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EFFECT OF VARIOUS INTAKE DESIGNS
ON ZOOPLANKTON ENTRAINMENT

by

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ABSTRACT

Field studies were conducted at the intakes of three Tennessee Valley Authority electric power plants to determine whether intake design is a feasible means of mitigating effects on zooplankton by minimizing the quantity entrained. Three intake designs were evaluated: one with a shallow skimmer wall, one with a deep skimmer wall, and one with no skimmer wall. Many sample sets from these studies were highly variable because of inadequate sample replication, thus precluding the use of statistical tests on some of the data. Where possible, an analysis of variance and a Student, Newman, Keuls multiple range test were computed and tested at the 0.05 level.

Several studies indicated possible differences between day and night in the quantity of zooplankton entrained. The greater quantities entrained at night were related to a greater abundance in the source water body at night rather than to intake design. These results indicate that time-of-day differences might be used to mitigate effects on zooplankton at some intakes if the intake could be operated to require less cooling water when concentrations were greatest.

None of these studies indicated that the intake designs studied minimized the quantity of zooplankton entrained because the quantities in the intake canals were similar to the quantities in the source water body.

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ABBREVIATIONS AND SYMBOLS

ANOVA	analysis of variance
BAT	best available technology
BFNP	Browns Ferry Nuclear Plant
°C	degrees Celsius
cm	centimeter
DO	dissolved oxygen
ft MSL	feet above mean sea level
h	hour
in.	inch
L	liter
m	meter
m ³	cubic meter
min	minute
mL	milliliter
MW	megawatt
μ	micron, micrometer
no.	number
SNK	Student, Newman, Keul's multiple range test

SECTION 1

INTRODUCTION

Electrical power generation in the United States has increased drastically in the past few years and is expected to increase at an even faster rate in future years. At present, about 80 percent of the annual generation of electrical power is produced by steam-electric power stations, which circulate large volumes of cooling water through condensers to extract waste heat. The amount of water annually withdrawn for this purpose is estimated to be about 15 billion cubic meters (40 trillion gallons) per year, which equals roughly 10 percent of the total flow of water in the rivers and streams of the contiguous United States (Sonnichsen et al. 1973).

The Federal Water Pollution Control Act, as amended in 1972 (Public Law 92-500), specifies under Section 316(b) ". . . that the location, design, construction, and capacity of cooling water intake structures reflect the best available technology for minimizing adverse environmental impacts. . . ." As a result of this law, utilities initiated studies to determine whether their intake structures reflected best available technology (BAT). In most cases, these studies were originally designed to determine the effects of entrainment (i.e., the process of being pulled through the condenser cooling system in the cooling water) on organisms small enough to pass through the trash racks--usually 1 cm (3/8 in.)--into the cooling system. In freshwater ecosystems, the organisms studied usually included holoplankton (phytoplankton and zooplankton) and meroplankton (drifting macroinvertebrates and fish eggs and larvae). Recently, however, emphasis has switched from the quantification of the immediate effects of entrainment to studies designed to determine the proportion of the entrainable organisms that is actually entrained into the condenser cooling water system.

PL 92-500 has also encouraged many research efforts to determine BAT for intakes. These research projects have centered around intake design and siting and have resulted in development of many new intake technologies to mitigate intake effects. These technologies have been summarized by Ray et al. (1976). Many of these technologies are still in the experimental stages, and only a few have widespread applicability. Although research efforts have increased greatly, few research projects have addressed the mitigation of effects on zooplankton. Zooplankton fill an essential role in most aquatic ecosystems by making the solar energy captured by the primary producers and chemical energy in organic detritus (via bacteria and fungi) available to the higher trophic levels (Cole 1975).

The need to mitigate effects on zooplankton is created by two interacting factors, one adding to the importance of the other. The first factor involves the effects, both immediate and latent, that were reported in some of the initial studies to determine entrainment effects. The second is the ever-increasing demand for electrical power, which means that more and more electrical power stations must be built, with a concomitant increase in water used in condenser cooling systems. The entrainment effects documented cover a broad spectrum; for example, Icanberry

(1973) found insignificant effects at one Pacific Coast plant, Heinle (1969) reported decreases in reproductive potential, and Carpenter (1974) identified high percentages of copepods killed. Although some studies reported significant effects, recovery of the zooplankton downstream from a plant has been reported by Davies and Jensen (1975). This recovery was apparently due to reproduction by the unaffected portion of the community; that is, the species comprising the community had the resiliency to withstand the impact and were able to maintain community integrity. Most zooplankton species should have the resiliency to recover population losses, provided that the species has a short generation time and that a large proportion of the population has not been affected. However, if the opposite is true (long generation or a large portion affected), recovery probably would be impaired. An additional effect of entrainment has been recognized by Bunting (1974). He indicates that the real impact of entrainment is the discharge of an altered community to the receiving water body because this alteration has the potential to affect predator-prey relationships in the receiving water body.

The second factor that creates the need to mitigate effects on zooplankton, which is additive to the first, is the operation of more and more new power plants built to meet the ever-increasing demand for electricity. Entrainment of zooplankton into the condenser cooling water systems of the new plants represents repeated assaults on the community. These repeated assaults could threaten the recovery (the resiliency) of the community by progressively decreasing the unaffected portion.

Mitigation of effects on zooplankton might be possible by intake design or intake siting. Bunting (1974) states that the quantity of zooplankton entrained is related to (1) the horizontal and vertical distribution patterns of the organisms near the intake and (2) the interaction of these patterns with time of day, intake position, species composition, and flow.

Intake design and siting could minimize the quantity of zooplankton entrained either by one mechanism or a combination of two mechanisms. One is active avoidance, by which the stronger-swimming zooplankton species move away from the currents produced by the intake. This avoidance mechanism has been recognized by Singarajah (1969), who suggests that it may have evolved as a means to evade predation. Brook and Woodward (1956) reported zooplankton avoidance of a dam outfall and found this avoidance to be more pronounced in mature specimens. Because an intake for a dam outfall and an intake for a power plant would exert similar hydrological pressures (assuming similar depths) on the zooplankton, avoidance of a plant intake appears to be a real possibility. The other mechanism that could minimize entrainment would be to withdraw water low in zooplankton numbers for use in condenser cooling systems. These depauperate waters could be used by siting an intake in areas of low zooplankton concentrations or by pulling water from those strata that have low zooplankton concentrations (the vertical distribution of zooplankton is discussed by Hutchinson 1967).

The purpose of this research project was to determine whether intake design is a feasible means of mitigating effects on zooplankton by minimizing the quantity entrained. The Tennessee Valley Authority (TVA) has used several different types of intake designs at existing power plants.

These intakes can generally be divided into four types (Figure 1): (1) those with a skimmer wall in an intake channel with a relatively shallow depth (type A), (2) those with a skimmer wall and relatively deep (type B), (3) those with a short intake canal but no skimmer wall (type C), and (4) those located directly on the shoreline (type D). This report covers the results of studies conducted on zooplankton entrainment at intake types A, B, and C and a three-dimensional hydraulic computer model at intake type B.

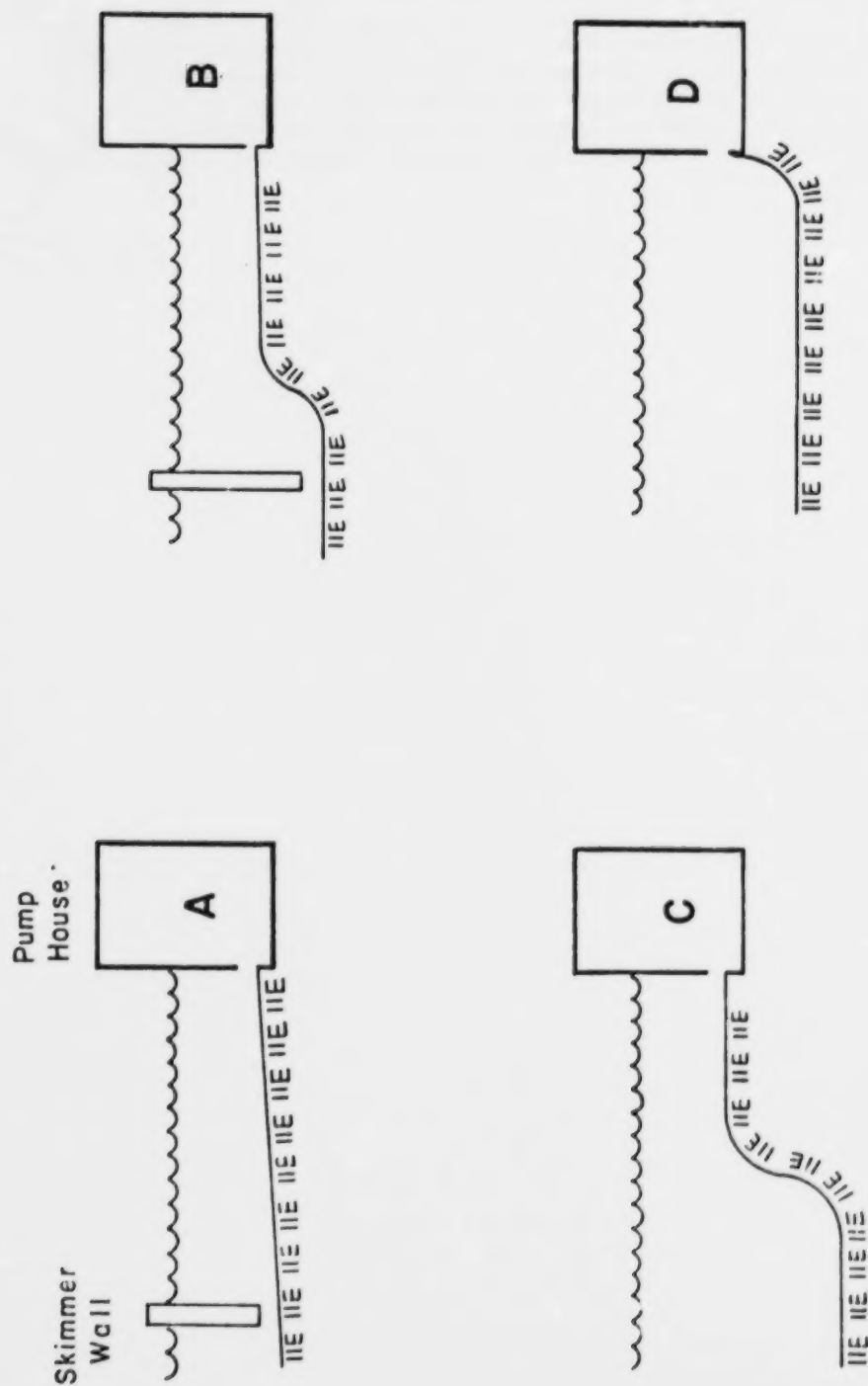


Figure 1. Intake types evaluated. Intake A has a skimmer wall and relatively shallow (<10 m) depth; intake B is similar to intake A, but is deeper (>10 m); intake C has a short intake canal and no skimmer wall; and intake D is situated directly on the shoreline.

SECTION 2

CONCLUSIONS

INTAKE TYPE A

Several studies at intake type A indicated a possible trend of attraction or concentration in the intake forebay because the zooplankton number and biomass were frequently greatest at this sampling point. However, this trend was statistically significant in only a few studies. Increased sample size might possibly have increased the resolving capacity of the statistical tests, allowing clarification of the possible trend.

These studies also showed that the biomass entrained was greater at night than during the day and that these larger amounts probably resulted from increased numbers of copepods in the source water body. These results indicate that time-of-day differences in the concentration of zooplankton might possibly be used to mitigate effects if an intake could be operated to require less cooling water when concentrations of organisms were greatest.

None of the studies at intake type A indicate that the type of intake minimizes the quantity of zooplankton entrained.

INTAKE TYPE B

The studies conducted at intake type B must be used with discretion because of problems with sampling gear in one series of studies and because of high variability between many sets of replicate samples in the other series of studies. These studies provided some evidence that the quantity of crustacean zooplankton entrained might have been high at this type of intake because the cooling water is withdrawn from the lower strata, which were richer in crustaceans than the upper strata. In general, these studies indicated that the quantity of zooplankton entrained probably was not minimized by this type of intake.

INTAKE TYPE C

Because only one study was conducted at this type of intake, conclusive statements are premature. However, the data from this study do indicate that this type of intake probably does not minimize the quantity of zooplankton entrained.

SECTION 3

RECOMMENDATIONS

The data from the studies summarized in this report are variable and, therefore, preclude definitive conclusions. The variability between samples experienced in these studies could be decreased by redesign of some of the sampling and enumeration procedures, thereby allowing better resolution of the trends identified by these data. However, we do not recommend that such redesign be undertaken at this time for two reasons:

1. Although variable, these data do indicate that none of the intakes studied minimizes the quantity of zooplankton entrained.
2. Because closed-cycle cooling is apparently the best available technology (BAT) for Section 316(a) of the Federal Water Pollution Control Act Amendments of 1972 (PL 92-500), the cooling water demand for new intakes will be greatly reduced from what it would be for open, once-through cooling. Therefore, construction of new power plants with closed-cycle cooling does not represent as much of a potential environmental impact as does construction of plants with open, once-through cooling.

We recommend that, if BAT is changed to open, once-through cooling, this research should be resumed and redesigned to identify ways to mitigate potential effects represented by the increased water demand of once-through cooling.

SECTION 4

MATERIALS AND METHODS

FIELD

General Study Plan

The studies reported here used one of two basic plans. One plan involved sampling a watermass as it moved downstream near an intake (Figure 2). The watermass was sampled simultaneously at points on an upstream transect, followed downstream with subsurface drogues, and sampled at points on another transect as the watermass neared the intake. One point on the "intake transect" was within the intake canal. The other plan, used when irregularities in reservoir flow prevented following a watermass, involved sampling from anchored boats positioned at points along a transect in line with and within the intake canal.

Most studies were conducted during daylight (diurnal); however, two studies involved sampling over a full 24-h (diel) period. Samples for diel studies were collected before and after sunrise, at noon, before and after sunset, and at midnight. The study plan used and the period sampled for each study are presented in Table 1. Any deviations from the general study plan are described in the results and discussion for each study.

Sample Collection

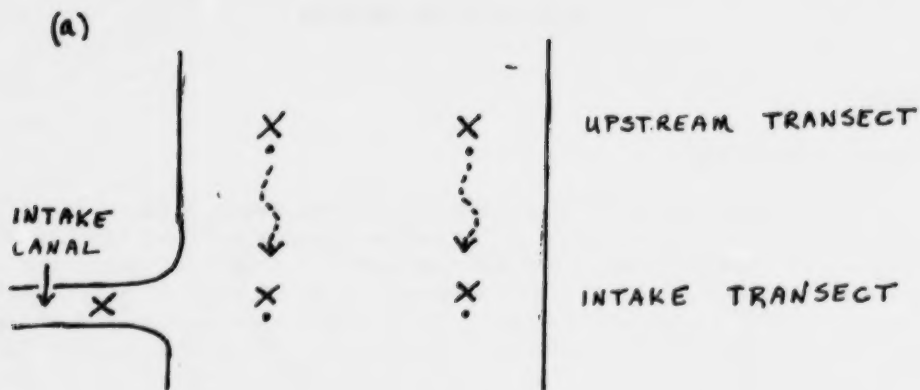
Zooplankton samples for these studies were collected with either a plankton net or a trap sampler. The plankton net was rigged with a flow-meter suspended in the throat (used to estimate the volume of water filtered) and an opening device (used to open the net when lowered to the desired depth). The trap sampler, made of plexiglass, had hinged doors at the top and bottom, which were open during descent and then closed when the descent was stopped at the desired depth, trapping about 50 L of water inside. For a more detailed description of the sampling devices, see Dycus and Wade (1977) for details of the plankton net and Schlinder (1967) for details of the trap sampler.

Selected water quality parameters (DO, pH, temperature, and conductivity) were monitored for specific studies using an in situ water quality monitor. Current velocity and direction of flow were monitored at selected depths with a current meter.

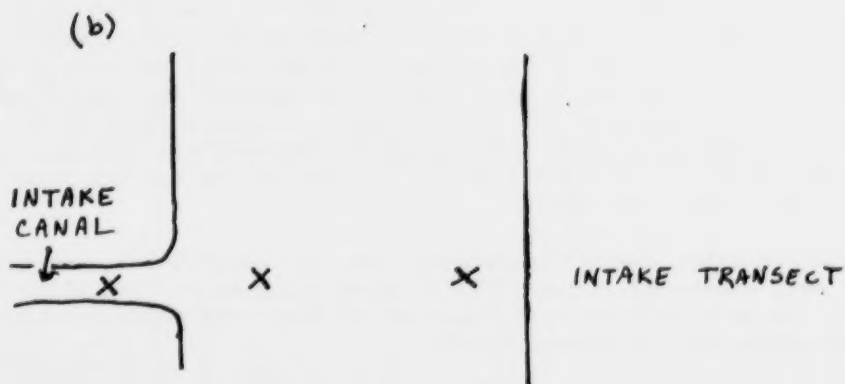
LABORATORY

Enumeration

Samples were diluted or concentrated, depending on the abundance of detritus and organisms, to a volume that would allow expeditious, but thorough, enumeration. A 1-mL Hensen-Stempel pipette was used to remove 1-mL subsamples from the magnetically stirred sample; the subsamples were



- X - SAMPLING POINT (BOATS NOT ANCHORED EXCEPT IN INTAKE CHANNEL)
- - DROGUE (USED TO FOLLOW WATER MOVEMENT)
- ↓ - WATERMASS MOVEMENT



- X - SAMPLING POINTS, ALL BOATS ANCHORED

Figure 2. Two basic sampling plans used in studies. Samples were collected from (a) a watermass as it moved downstream and (b) anchored boats positioned at points along the intake transect.

TABLE 1. STUDY PLAN USED FOR EACH STUDY CONDUCTED
AT VARIOUS TYPES OF INTAKES

Intake type	Date	Power plant	Daylight or diel	Study plan
A	May 18, 1977	Browns Ferry Nuclear Plant	Daylight	Watermass
A	June 7, 1977	Browns Ferry Nuclear Plant	Daylight	Watermass
A	June 8, 1977	Browns Ferry Nuclear Plant	Daylight	Watermass
A	July 19, 1977	Browns Ferry Nuclear Plant	Daylight	Watermass
A	July 20-21, 1977	Browns Ferry Nuclear Plant	Diel	Watermass
B	September 22, 1976	Gallatin Steam Plant	Daylight	Anchored
B	September 23, 1976	Gallatin Steam Plant	Daylight	Anchored
B	September 20-21, 1977	Gallatin Steam Plant	Diel	Anchored
C	May 25, 1977	Colbert Steam Plant	Daylight	Watermass

then individually placed into a Sedgewick-Rafter counting chamber. Organisms were enumerated at the lowest practical taxonomic level, usually species.

The subsamples were enumerated on a compound microscope at 35X or 50X magnification. Sufficient subsamples were enumerated until at least 400 organisms were included (Elliot 1971). If the 400 minimum could not be attained in five subsamples, the entire sample was concentrated, and all specimens were counted. The resulting laboratory counts were extrapolated to total numbers in the sample, and then these numbers were transformed to numbers per cubic meter. References and publications used in identifications included Ahlstrom (1940, 1943), Brooks (1957), Deevey and Deevey (1971), Goulden (1968), Harring and Myers (1926), Ruttner-Kolisko (1974), Voight (1956), and Ward and Whipple (1959).

Biomass

Each sample was concentrated to 20 mL in preparation for the sucrose gradient centrifugation separation procedure. The sample was placed in a plastic centrifuge tube, to which 20 mL each of two dyed sucrose solutions (specific gravities 1.3472 and 1.5518) were introduced, with the lightest first, at the bottom of the tube. The tubes were then placed in an automatic centrifuge and centrifuged at 10,000 rpm for 10 min. This centrifugation separated the detritus and most phytoplankton from the zooplankton, which remained suspended in the sucrose gradients. After centrifugation, the solutions (water and two sucrose gradients) were removed with a pipette connected to an auto-pipette filler with a 100-mL pipette inline. Care was taken not to include any of the detrital pellet at the bottom of the tube. Some of the zooplankton tended to deposit along one side of the tube; to prevent losing these zooplankton, the detrital pellet was removed, and the streak was washed into the solution containing the sample. The sample was then transferred to a Wisconsin plankton bucket (equipped with #20 mesh Nitex bolting cloth) and rinsed for several minutes to assure complete removal of all sucrose. After washing, the sample was filtered onto a preweighed 14.0- μ m Millipore filter, where the zooplankton were deposited. The filter pads were placed in a crucible and dried for 24 h at 105°C. Eight pads from each 20-pad lot were washed with an equivalent amount of distilled water and then dried for 24 h at 105°C to obtain an average weight-loss factor for the filter pad lot. After cooling in a desiccator, the pads were reweighed and expressed as milligrams dry weight per cubic meter.

DATA ANALYSES

Combined sample collecting and processing precision was evaluated using standard deviations and coefficients of variation. A coefficient of variation below 20 percent was considered to show good sample replicability. A coefficient of variation between 20 and 40 percent was considered to show acceptable, yet borderline, sample replicability. A coefficient of variation above 40 percent was considered to indicate that some problems existed between replicate samples.

Data interpretations were based on a qualitative examination of the data in which trends were identified and, for certain data sets, on statistical tests in which significant differences were identified. If less than three-fourths of the sample sets for a study had coefficients of variation below 40 percent, statistical analyses were not conducted for that study. If three-fourths or more of the sample sets had coefficients of variation below 40 percent, an analysis of variance (ANOVA), with hypothesis testing at the 0.05 level, was used to determine whether significant differences could be detected. If significant differences were detected, the means were subjected to the Student, Newman, and Keuls multiple range test (SNK), performed according to Sokal and Rohlf (1969). Analyses were performed on total zooplankton biomass, total zooplankton number, zooplankton group numbers (Rotifera, Cladocera, Calanoida, and Cyclopoida), Copepoda larvae (nauplii) numbers, and numerically dominant species or category (generic level identification or immature forms that would not allow species level identification) numbers within each zooplankton group.

Before statistical tests, all enumeration data were transformed using square root, and all biomass data were transformed using $\log_{10}$ (Sokal and Rohlf 1969). Transformations were performed in an attempt to normalize the data. However, even after transformation, some data sets were heteroscedastic. Although statistical tests were run on these data sets, they were used to show trends in the data rather than significances. Heteroscedastic data sets are identified in the tables summarizing the results of the statistical tests (Section 5, Tables 3-6, 8, 9, 11, and 14).

SECTION 5

RESULTS AND DISCUSSION

STUDIES AT INTAKE TYPE A

Browns Ferry Nuclear Plant (BFNP) was selected as the study site for intake type A (Figure 1).

Physical Description

TVA's Browns Ferry Nuclear Plant is situated on Wheeler Reservoir on the Tennessee River in northern Alabama (Figure 3). This plant is a 3-unit, nuclear-fueled facility with a design capacity of 3456 MW. The intake for the condenser cooling water for the plant is situated at Tennessee River Mile (TRM) 294. The underwater topography of the river near the intake (Figure 4) reveals depths of about 10 m (33 ft). The cooling water from the river flows to the plant through an intake channel, which is about 150 m (487.5 ft) long. The channel is separated from the Tennessee River by a 60-m (200-ft) long skimmer wall, which extends 2.8 m (9.1 ft) below the water surface when the reservoir surface is at normal full pool [elevation 170 m (556 ft) above mean sea level (MSL)]. This leaves about a 7.3-m (24-ft) high opening under the bottom of the wall.

The plant was originally designed for once-through or "open mode" condenser cooling. In this mode, water is pumped from the river at 125 m³/s (4410 ft³/s), and most of the water flows through the steam condenser, where the cooling water is heated before being discharged through submerged multiport diffusers in the river. To meet more stringent thermal water quality standards, the plant has been retrofitted with six mechanical-draft cooling towers. The cooling towers may be operated in helper or closed mode, as needed, to meet the thermal standards. With the towers in "helper mode" and operating at designed capacity, the plant withdraws 104 m³/s (3675 ft³/s) of water from the river. When operating at designed capacity in the "closed mode," the plant uses 5.7 to 8.5 m³/s (200 to 300 ft³/s) of water, most of which is "makeup" for the cooling system.

Wheeler Reservoir was created in 1936 by the impoundment of the Tennessee River at Wheeler Dam (TRM 275). River flows near the plant depend primarily on discharges from Guntersville Dam (TRM 349), which is 80 km (55 miles) upstream, and from Wheeler Dam (TRM 349), which is 31 km (19 miles) downstream. The mean annual flow rate of the river at BFNP is 1270 m³/s (45,000 ft³/s).

The 23-km (14-mile) reach upstream of the plant is characterized by a main river channel, which was the original riverbed, flanked by wide, shallow overbank regions. The main channel is about 9 m (30 ft) deep and 600 m (2000 ft) wide. The right overbank region immediately upstream from the plant is relatively shallow, except for an old creek channel adjacent to the right bank, which is about 6 m (20 ft) deep. However, when the reservoir elevations are near maximum, depths in most of the right overbank region upstream from the plant range from 1.5 to 3 m (5 to 10 ft). During low reservoir elevations, the overbank is exposed in some regions and is about 1 m (3 ft) deep in others.

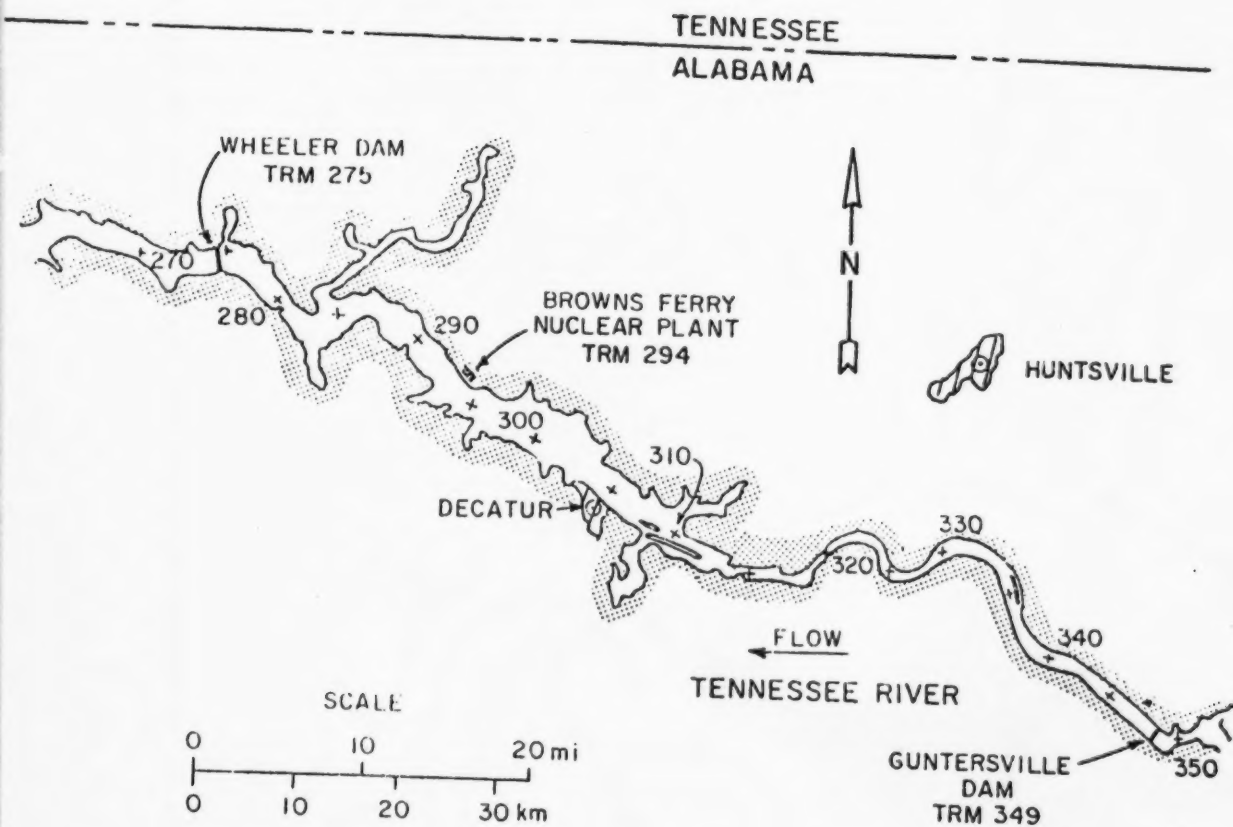


Figure 3. Location map of Browns Ferry Nuclear Plant.

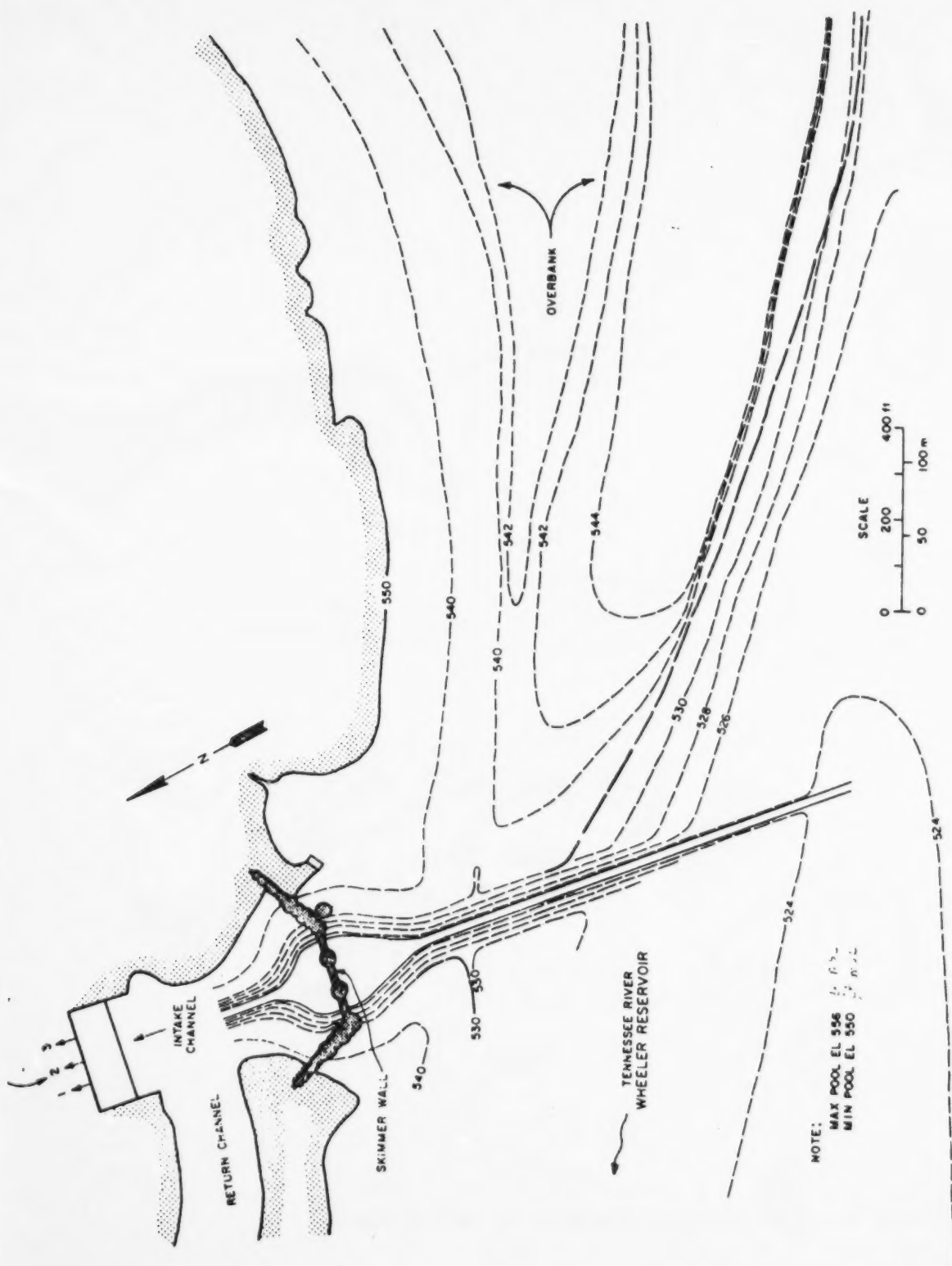


Figure 4. Underwater topography near the Browns Ferry Nuclear Plant intake.

Specific Study Methods

All studies conducted at BFP used transect sampling of a moving watermass. In studies conducted from May 21, 1977, through July 19, 1977, four points along the upper transect were sampled--two points in the channel and two points on the right overbank. As the watermass neared the intake, samples were collected from five points--two points in the channel, two points in the dredged channel leading to the skimmer wall, and one point in the intake forebay between the skimmer wall and pumphouse (Figure 5). In a diel study conducted on July 20 and 21, 1977, zooplankton biomass samples were collected similarly, except that enumeration samples were collected from fewer points--two points along the upstream transect (one in the midchannel and one on the overbank) and three points along the transect near the intake (one in the midchannel, one in the dredged channel, and one in the intake forebay). The specific methods for these studies are presented in Table 2.

Studies Conducted on May 18, June 7 and 8, and July 19, 1977

The purpose of these studies was to determine whether this intake minimizes the quantity of zooplankton biomass entrained. Total biomass was selected because it provides an economical means (the time for laboratory sample processing for biomass is much less than that required for enumeration) for determining zooplankton quantities in the source water body and in the intake. However, total biomass provides only gross information and is therefore limited because it cannot define the quantity of individual zooplankton groups or species entrained.

Individual sample set data for these studies are presented in Appendix A. Sample collection and processing precision are summarized in Appendix A by using means, standard deviations, and coefficients of variation. The coefficient of variation provides a comparison of the magnitudes of standard deviations, regardless of the sizes of the means (Sokal and Rohlf 1969). Analysis of the coefficients of variation indicates that most of these values (almost three-fourths) are below 40 percent, the value commonly used in other TVA field sampling programs as the limit that indicates problems with sampling and processing precision (Urban et al. 1976, 1977a, and 1977b). However, the values for the sample sets collected for this study are skewed toward the 40 percent limit, indicating slightly more variability than desired.

Qualitative examinations of these data show that, when all sampling points are compared, the point in the intake forebay had the highest biomass for five of the seven watermasses sampled. The consistency of this station having the highest biomass indicates a possible trend toward concentration at or attraction to the intake. Reproduction is not considered a viable explanation for the higher biomass because the high velocity at the sampling point in the intake forebay was too great to allow sufficient time for reproduction to occur.

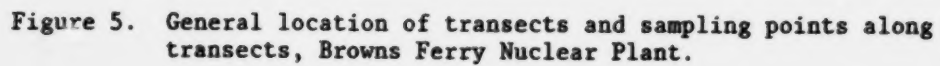


TABLE 2. SPECIFIC METHODS FOR STUDIES CONDUCTED AT BROWNS FERRY NUCLEAR PLANT INTAKE

Date	Time	Water- mass no.	Type sampler used	Depths sampled	No. replicates each depth	Laboratory analysis		Cooling mode
						Enumeration	Biomass	
May 18, 1977	0900-1100 1300-1500	1	Net	Bottom to surface	5	No	Yes	Open
		2	Net	Bottom to surface	5	No	Yes	Helper
June 7, 1977	0900-1100 1300-1500	1	Net	Bottom to surface	5	No	Yes	Helper
		2	Net	Bottom to surface	5	No	Yes	Helper
June 8, 1977	1300-1500 1800-2000	1	Net	Bottom to surface	5	No	Yes	Helper
		2	Net	Bottom to surface	5	No	Yes	Open
July 19, 1977	0900-1100	1	Net	Bottom to surface	5	No	Yes	Mixed ^a
		Diel study ^b						
July 20, 1977 July 21, 1977	1900-2100 2300-0100 0300-0500 0700-0900 1100-1300 1600-1800	1	Net	Bottom to surface	5	No	Yes	Mixed ^a
		2	Net	Bottom to surface	5	No	Yes	Mixed ^a
		3	Net	Bottom to surface	5	No	Yes	Mixed ^a
		4	Net	Bottom to surface	5	No	Yes	Mixed ^a
		5	Net	Bottom to surface	5	No	Yes	Mixed ^a
		6	Net	Bottom to surface	5	No	Yes	Mixed ^a
July 20, 1977 July 21, 1977	1900-2100 2300-0100 0300-0500 0700-0900 1100-1300 1600-1800	1	Trap	1, 4, and 7 m	3	Yes	No	Mixed ^a
		2	Trap	1, 4, and 7 m	3	Yes	No	Mixed ^a
		3	Trap	1, 4, and 7 m	3	Yes	No	Mixed ^a
		4	Trap	1, 4, and 7 m	3	Yes	No	Mixed ^a
		5	Trap	1, 4, and 7 m	3	Yes	No	Mixed ^a
		6	Trap	1, 4, and 7 m	3	Yes	No	Mixed ^a

^aAny combination of two of the three cooling modes.

^bTrap samples for the diel study were collected immediately after net samples and were collected from the same locations, except that the number of points sampled was reduced--upstream, channel one point and overbank one point; near intake, channel one point, dredged channel leading to wall one point, inside intake forebay, one point.

Results of a one-way analysis of variance (ANOVA) and, if significance occurred, a Student, Newman, Keuls multiple range test (SNK), including all sampling points for each study, are presented in Table 3. These tests show that, even though the sampling point in the intake forebay usually had a higher biomass than the sampling points outside the skimmer wall, the biomass at this point was statistically significantly higher than those from the other sampling points in only two studies.

These data indicate that this intake probably does not minimize the quantity of zooplankton biomass entrained, since the biomass for the intake forebay differed significantly from that at the other stations in only 28.6 percent of the watermasses studied. However, increased sample size might possibly have increased the resolving capacity of the statistical tests, allowing clarification of the possible trend of higher biomass at the intake forebay.

Studies Conducted on July 20 and 21, 1977 (Diel Study)

The purposes of these studies were to (1) determine whether the quantity of zooplankton biomass entrained fluctuates with time of day over a 24-h period, (2) determine the quantity of individual zooplankton groups and species entrained, and (3) determine whether the quantity of individual groups and species entrained exhibits any periodicity over a diel cycle.

Weather conditions during the study period were partly cloudy with scattered thundershowers. The cycle of sunlight during the diel study and a summary of individual sampling times are presented in Figure 6. Periods of clouds and thundershowers are evident at 1200 and 1415 hours on July 21, but this thundershower activity was of short duration. Water temperature during the study ranged from 29 to 30°C, with little stratification evident.

Individual sample set data for these studies are presented in Appendix B (total zooplankton biomass) and Appendix C (enumeration for total zooplankton number, group number, and numerically dominant species number). Sample collection and processing precision are summarized in these appendixes using means, standard deviations, and coefficients of variation.

Examination of the coefficients of variation shows that most (more than three-fourths) of the sample sets for total biomass and total number have coefficients of variation below 40 percent. However, the distribution of coefficients of variation for the group totals and numerically dominant species is not as good. Therefore, statistical analyses were performed only on total biomass and total zooplankton. They were not performed on group totals or numerically dominant species because of high variability between replicate samples.

TABLE 3. RESULTS OF ANALYSIS OF VARIANCE AND STUDENT, NEWMAN, KEUL'S
MULTIPLE RANGE TEST (SNK) ON DATA COLLECTED MAY 18, 1977, to July 19, 1977,
AT BROWNS FERRY NUCLEAR PLANT

May 18, 1977

Watermass 1 ^b		Station rank for SNK ^a							
TDF	- 8	Lowest							Highest
EDF	- 36	1	5	6	2	3	7	8	4 9
Calculated F	- 4.41								
Tabular F	- 2.22								

Watermass 2 ^{b,c}					
TDF	- 4	5	7	6	8 9
EDF	- 20				
Calculated F	- 20.30				
Tabular F	- 2.87				

June 7, 1977

Watermass 1 ^b							
TDF	- 8	8	2	6	4	5	3
EDF	- 31						9
Calculated F	- 2.53						1
Tabular F	- 2.26						

Watermass 2 ^b									
TDF	-	8							
EDF	-	36	7	3	4	5	2	6	1
Calculated F	-	7.66							
Tabular F	-	2.22							

June 8, 1977

Watermass 1 ^b									
TDF	- 8	8	4	1	7	2	3	6	5
EDF	-36								9
Calculated F	- 9.45								
Tabular F	- 2.22								

Watermass 2 ^b									
TDF	- 8	3	1	4	5	7	6	2	8
EDF	-36								9
Calculated F	- 6.93								
Tabular F	- 2.22								

TABLE 3 (continued)

		<u>July 19, 1977</u>								
Watermass 1 ^b		Station rank for SNK ^a								
		Lowest								Highest
		5	3	7	8	1	4	2	9	6
TDF	- 8									
EDF	-36									
Calculated F	- 7.82									
Tabular F	- 2.22									

^aStation number:

- 1 = upstream transect, channel, point 1
- 2 = upstream transect, channel, point 2
- 3 = upstream transect, overbank, point 1
- 4 = upstream transect, overbank, point 2
- 5 = intake transect, channel, point 1
- 6 = intake transect, channel, point 2
- 7 = intake transect, dredged channel, point 1
- 8 = intake transect, dredged channel, point 2
- 9 = intake forebay

^bAbbreviations: TDF = treatment degrees freedom; EDF = error degrees freedom; tabular F = at 0.05 level.

^cSamples from upstream transect were not preserved after collection in field.

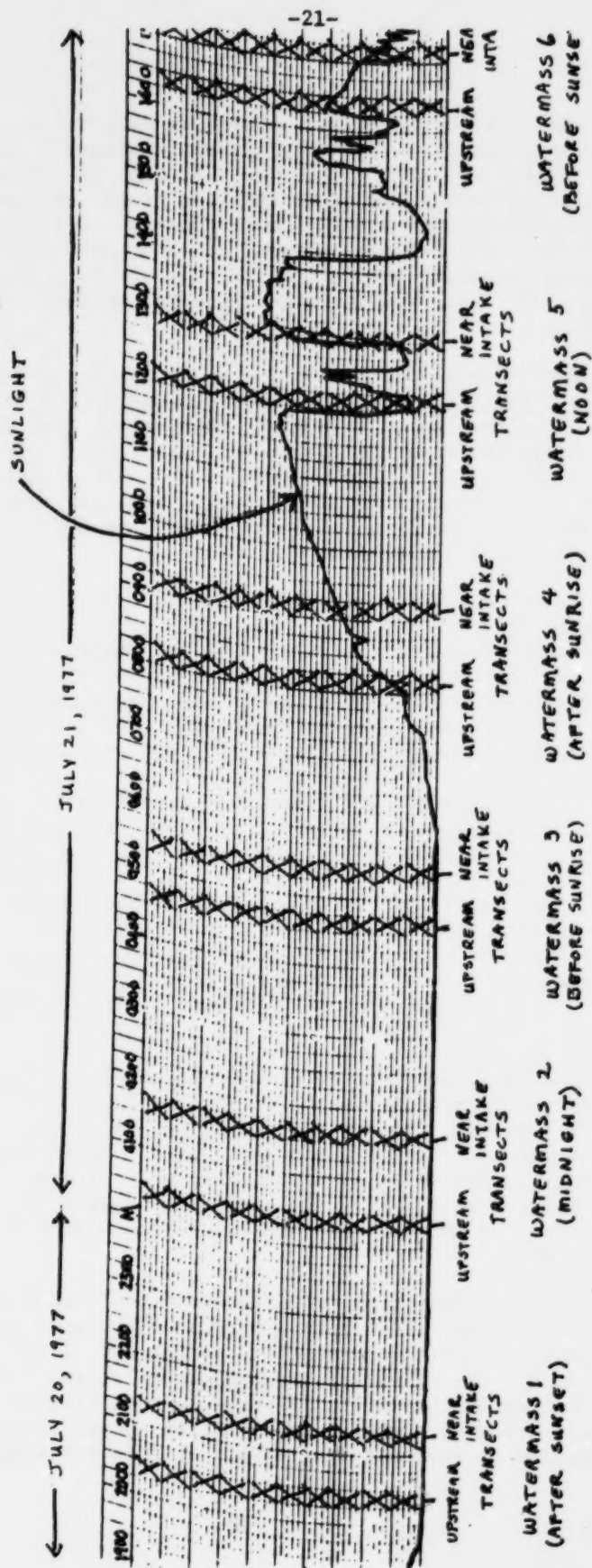


Figure 6. Cycle of sunlight during diel study conducted July 20 and 21, 1977, at Browns Ferry Nuclear Plant. Individual sampling times (CDT) using military notation are shown.

The qualitative interpretation of the biomass data did not reveal any trends of one sampling point being consistently higher or lower. However, when the biomass data were examined with time as the variable, the biomasses collected during the night sampling times (watermasses 1, 2, and 3) appeared to be higher at all sampling points than those collected during the day. Because all sampling points showed the same trends (i.e., higher during the night than during the day and no point consistently being higher or lower than the other points), neither avoidance of nor attraction to the intake is indicated.

The biomass data were tested statistically by using a 2-way ANOVA, with sampling points and sampling times (watermasses) as the variables. Table 4 summarizes the results of this test, which shows that interaction between sampling times and sampling points was significant. This significant interaction indicates that these variables were not acting independently of each other. Therefore, differences in sampling times at specific sampling points and differences in sampling points at specific sampling times were examined individually using the SNK.

The SNK for sampling point significances showed various groupings, with no trends being evident (Table 5). However, for the analyses over time, the significant differences identified by the SNK were usually between the night and day sampling times. Table 6 shows that the biomasses at all sampling points were highest during the night (watermasses 1, 2, and 3) and that these were significantly higher (indicated by the SNK) for many sampling points, especially those along the near intake transect.

Hence, the biomass data for the diel study showed that, although significantly more zooplankton biomass was entrained during the night, the larger amounts were probably not due to attraction, but rather to an increased amount in the source water body. This increased amount at night could have been caused by (1) a naturally higher biomass in the watermasses sampled at night, (2) vertical migration where the heavier zooplankters (the crustaceans) moved from near bottom up into the open water column, or (3) less avoidance of the sampling gear during the night. Whatever the cause, it does not seem to have been related to the intake structure.

The enumeration data for the diel study, presented as the mean number per cubic meter for each sampling depth of each sampling time, for total zooplankton, total Rotifera, total Cladocera, total Calanoida, total Cyclopoida, and nauplii are presented in Appendix C. These data show that Rotifera was the numerically dominant zooplankton group. Hence, trends observed in total zooplankton are essentially those reflected by total Rotifera; trends in the other groups had only a slight bearing on changes in total number.

The qualitative interpretation of the enumeration data showed that, regardless of depth or time, the Rotifera were almost always more numerous at the sampling point in the intake forebay than at any of the other sampling points. Data for the other zooplankton groups showed a similar trend of higher numbers in the intake, although not so frequently as for the Rotifera. This trend of higher numbers in the intake forebay indicates an apparent attraction or concentrating effect at this sampling point.

TABLE 4. RESULTS OF 2-WAY ANALYSIS OF VARIANCE ON BIOMASS DATA
COLLECTED DURING DIEL STUDY ON JULY 20 AND 21, 1977, AT
BROWNS FERRY NUCLEAR PLANT^a

Source of variation	Degrees freedom	Sums of squares	Mean square	F ratio
Between times	5	14.9394	9.9394	489.626 ^b
Between stations	8	1.7264	0.2158	10.631 ^b
Interaction (times x stations)	40	3.5642	0.0891	4.389 ^b
Error	<u>216</u>	<u>4.3797</u>	0.0203	
Total	269	24.6097		

^aLog₁₀ transformation used on all data.

^bSignificant at 0.05 level.

TABLE 5. RESULTS OF STUDENT, NEWMAN, KEUL'S MULTIPLE RANGE TEST (SNK)
COMPARING BIOMASS DATA AT SAMPLING POINTS, DIEL STUDY--
JULY 20 AND 21, 1977, BROWNS FERRY NUCLEAR PLANT

	Station rank ^a								
	Lowest mean				Highest mean				
	<u>July 20, 1977</u>								
Watermass 1	2	4	1	3	5	6	9	7	8
	<u>July 21, 1977</u>								
Watermass 2	4	1	5	8	3	2	9	6	7
Watermass 3 ^b	1	6	5	2	3	4	9	8	7
Watermass 4	8	7	2	1	6	4	5	3	9
Watermass 5 ^b	8	7	2	5	9	1	3	6	4
Watermass 6	4	3	8	2	5	1	7	6	9

^aStation number: 1 = upstream transect, channel, point 1
2 = upstream transect, channel, point 2
3 = upstream transect, overbank, point 1
4 = upstream transect, overbank, point 2
5 = intake transect, channel, point 1
6 = intake transect, channel, point 2
7 = intake transect, dredged channel, point 1
8 = intake transect, dredged channel, point 2
9 = intake forebay

^bData were heteroscedastic.

TABLE 6. RESULTS OF STUDENT, NEWMAN, KEUL'S MULTIPLE RANGE TEST (SNK)
COMPARING BIOMASS FOR SAMPLING TIMES, DIEL STUDY--
JULY 20 AND 21, 1977, BROWNS FERRY NUCLEAR PLANT

	Time rank ^a					
	Lowest mean			Highest mean		
Upstream transect, channel, point 1 ^b	4	6	5	1	2	3
Upstream transect, channel, point 2 ^b	4	6	5	1	3	2
Upstream transect, overbank, point 1	6	4	5	1	2	3
Upstream transect, overbank, point 2	6	4	5	1	2	3
Near intake transect, channel, point 1	6	5	4	1	3	2
Near intake transect, channel, point 2	4	6	5	3	1	2
Near intake transect, dredged channel, point 1	4	5	6	2	1	3
Near intake transect, dredged channel, point 2 ^b	4	5	6	2	3	1
Intake forebay	5	4	6	2	3	1

^aTime number: 1 = after sunset (watermass 1)
2 = midnight (watermass 2)
3 = before sunrise (watermass 3)
4 = after sunrise (watermass 4)
5 = midday (watermass 5)
6 = before sunset (watermass 6)

^bData were heteroscedastic.

When the enumeration data from the diel study were examined qualitatively over time (watermasses 1, 2, and 3 at night and watermasses 4, 5, and 6 during daylight), differences in night and daylight sampling times were apparent only for Calanoida, D. pallidus, Cyclopoida, M. edax, and nauplii. Figures 7 and 8 show the diel enumeration data for each sampling depth at each sampling point for total zooplankton and for Calanoida, respectively. These figures were prepared by setting the largest mean number for each category (i.e., total zooplankton, Rotifera, etc.) equal to one and then determining the proportion of each mean in the category of this number. (Square roots were used in all calculations.) For example, Figure 7 shows that the largest mean total number of zooplankton was collected in the intake forebay at 1 m during the after-sunset sampling time. This figure also shows that there was very little difference between the night and daylight sampling times at any of the sampling points. The most apparent trend indicated by Figure 7 is that the intake forebay usually had the largest mean number of zooplankton, regardless of depth or time. The Rotifera, B. angularis, Cladocera, and D. leuchtenbergianum showed similar patterns to those shown by total zooplankton number. As previously stated, the Calanoida, D. pallidus, Cyclopoida, M. edax, and nauplii generally showed higher numbers at all sampling points during the night sampling times than during the daylight sampling times. Figure 8 shows this trend for the Calanoida. These higher numbers of copepods probably account for higher biomasses observed for the night sampling times discussed earlier.

The enumeration data were tested statistically using a 3-way ANOVA with sampling points, sampling times (watermasses), and sampling depths as the variables. Table 7 summarizes the test results, which show a significant interaction between sampling points and sampling times and indicate that depth was not a significant factor either independently or as an interaction with the other variables. Therefore, differences in sampling points were compared for individual sampling times, and differences in sampling times were compared at individual sampling points using the SNK. Both sets of comparisons were made over all depths.

The results of the SNK comparing sampling points and the SNK comparing sampling times are presented in Tables 8 and 9, respectively. The tests in these tables show that there were no consistent trends of point or time significances.

Hence, the most apparent trend indicated by the enumeration data is toward higher numbers of copepod taxa (Calanoida, D. pallidus, Cyclopoida, M. edax, and nauplii) during the night sampling times. Statistical analyses on total zooplankton number did not show consistent significances.

Summary of Studies Conducted at Intake Type A--Browns Ferry Nuclear Plant

Several of the studies conducted at intake type A indicated a possible trend of attraction or concentration in the intake forebay since the zooplankton biomass and total number were frequently higher at this sampling point than at the other sampling points. Although this trend was apparent when the data were scanned qualitatively, statistical analyses

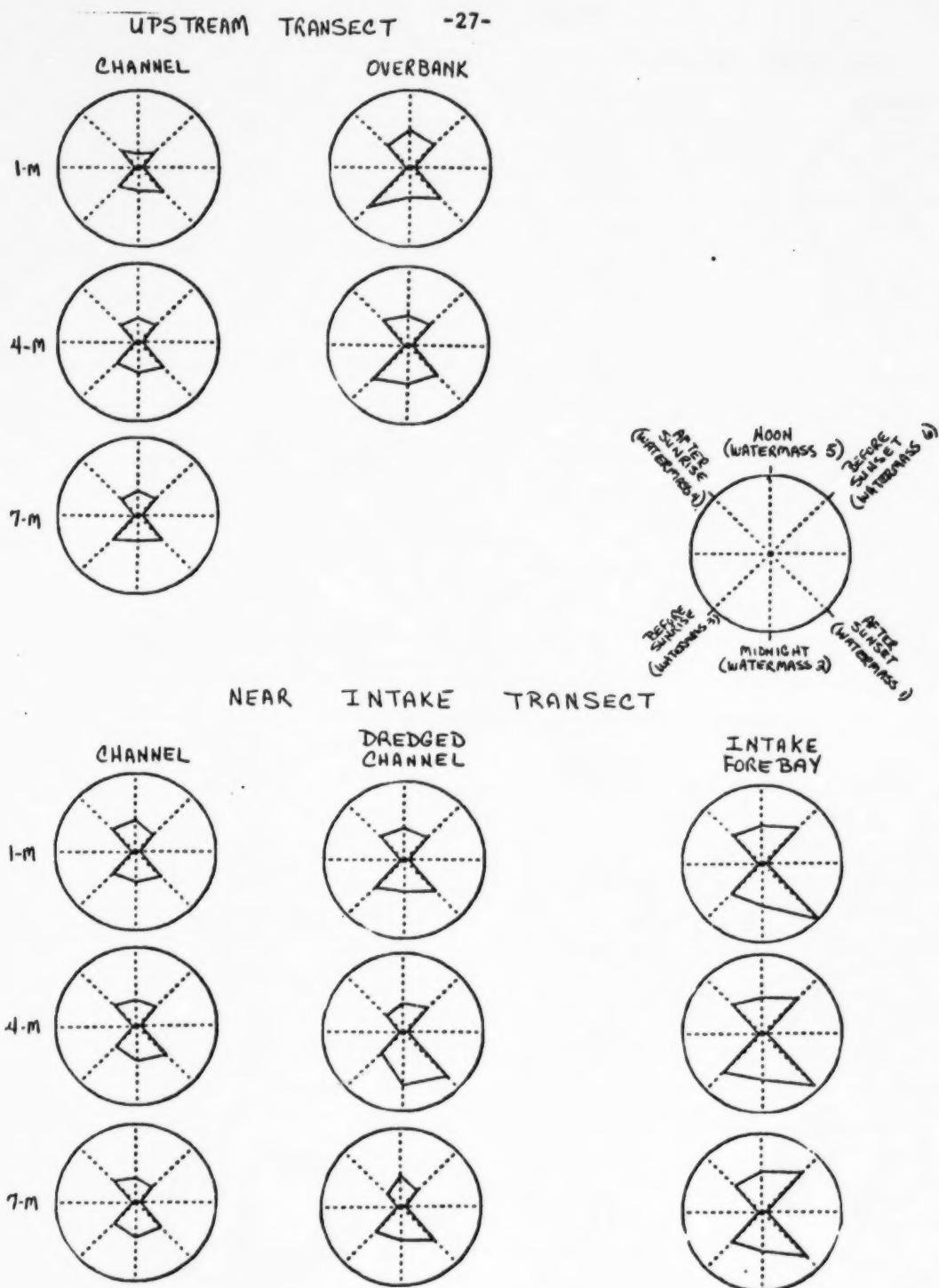


Figure 7. Diel enumeration data for total zooplankton for each sampling depth at each sampling point, Browns Ferry Nuclear Plant, July 20 and 21, 1977. Data are presented as the proportion of the largest mean number. Inset shows sampling times and water-mass numbers; data above the horizontal line in each circle are for daylight sampling times, whereas data below the line are for night sampling times.

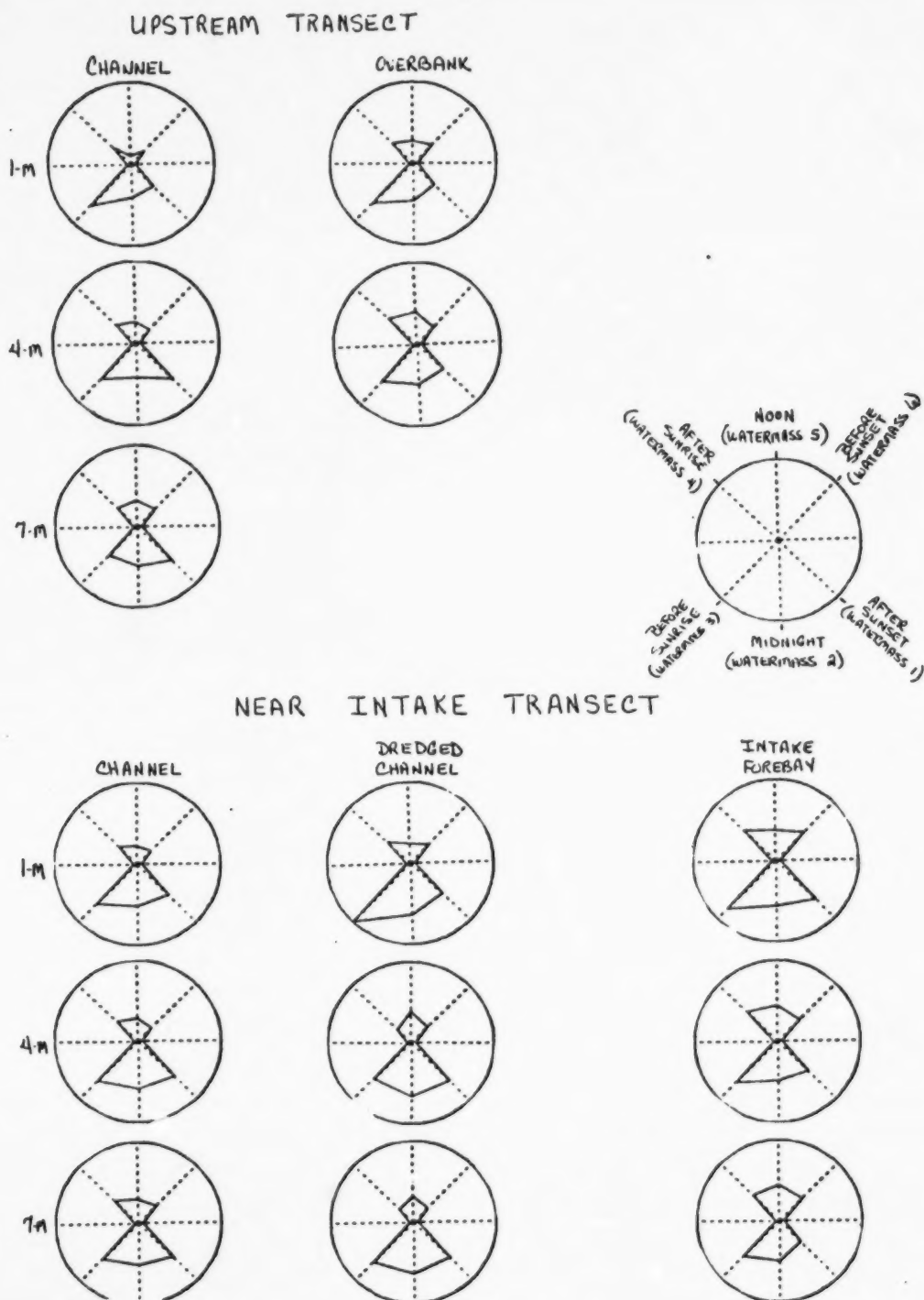


Figure 8. Diel enumeration data for *Calanoida* for each sampling depth at each sampling point, Browns Ferry Nuclear Plant, July 20 and 21, 1977. Data are presented as the proportion of the largest mean number. Inset shows sampling times and watermass numbers; data above the horizontal line in each circle are for daylight sampling times, whereas data below the line are for night sampling times.

TABLE 7. RESULTS OF 3-WAY ANALYSIS OF VARIANCE ON ENUMERATION DATA
(TOTAL ZOOPLANKTON NUMBER) COLLECTED DURING DIEL STUDY
ON JULY 20 AND 21, 1977, AT BROWNS FERRY NUCLEAR PLANT^a

Source of variation	Degrees freedom	Sums of squares	Mean square	F ratio
Between times	5	213,835.17	42,767.03	30.14 ^b
Between depths	1	2,658.23	2,658.23	1.87
Interaction (times x depths)	5	7,813.63	1,562.73	1.10
Between stations	4	375,798.07	93,949.51	66.20 ^b
Interaction (times x stations)	20	157,114.96	7,855.75	5.54 ^b
Interaction (depths x stations)	4	11,699.79	2,924.95	2.06
Interaction (times x depths x stations)	20	51,846.99	2,592.35	1.83 ^b
Error	119	168,882.15	1,419.18	
Total	178	989,649.99		

^aSquare root transformation used on all data.

^bSignificant at 0.05 level.

TABLE 8. RESULTS OF STUDENT, NEWMAN, KEUL'S MULTIPLE RANGE TEST (SNK)
COMPARING ENUMERATION DATA (TOTAL ZOOPLANKTON NUMBER) AT SAMPLING POINTS,
DIEL STUDY--JULY 20 AND 21, 1977, BROWNS FERRY NUCLEAR PLANT

	Station rank ^a				
	Lowest mean			Highest mean	
	<u>July 20, 1977</u>				
Watermass 1	<u>1</u>	<u>3</u>	<u>2</u>	4	5
	<u>July 21, 1977</u>				
Watermass 2	<u>1</u>	<u>3</u>	<u>2</u>	<u>4</u>	5
Watermass 3	<u>3</u>	<u>1</u>	<u>4</u>	5	2
Watermass 4	<u>1</u>	<u>4</u>	<u>3</u>	2	5
Watermass 5	1	<u>3</u>	<u>4</u>	<u>2</u>	5
Watermass 6	<u>1</u>	<u>3</u>	4	2	5

^aStation number: 1 = upstream transect, channel, point 1
 2 = upstream transect, overbank, point 1
 3 = intake transect, channel, point 1
 4 = intake transect, dredged channel, point 1
 5 = intake forebay

TABLE 9. RESULTS OF STUDENT, NEWMAN, KEUL'S MULTIPLE RANGE TEST (SNK)
COMPARING ENUMERATION DATA (TOTAL ZOOPLANKTON NUMBER)
FOR SAMPLING TIMES, DIEL STUDY--JULY 20 AND 21, 1977,
BROWNS FERRY NUCLEAR PLANT

	Time rank ^a					
	Lowest mean			Highest mean		
Upstream transect, channel, point 1	5	4	6	2	3	1
Upstream transect, overbank, point 1	6	4	5	2	1	3
Intake transect, channel, point 1	6	5	3	4	2	1
Intake transect, dredged channel, point 1	4	6	5	3	2	1
Intake forebay	6	3	4	2	1	5

^aTime number: 1 = after sunset (watermass 1)
2 = midnight (watermass 2)
3 = before sunrise (watermass 3)
4 = after sunrise (watermass 4)
5 = midday (watermass 5)
6 = before sunrise (watermass 6)

of the data indicated that this sampling point was significantly greater than the other sampling points in only a few of the studies. However, increased sample size might possibly have increased the resolving capacity of the statistical tests, allowing clarification of the possible trend.

These studies also showed that the biomass entrained was greater at night than during the day and that these larger amounts resulted from increased amounts in the source water body. The increases in biomass during the night sampling times were apparently related to increased numbers of calanoids, cyclopoids, and their larval stage, nauplii. These results indicate that time-of-day differences in the concentration of zooplankton might possibly be used to mitigate effects if an intake could be operated where less cooling water was required when concentrations were the greatest.

The studies at intake type A provide strong evidence that this type of intake does not minimize the quantity of zooplankton entrained.

STUDIES AT INTAKE TYPE B

Gallatin Steam Plant was selected as the study site for intake type B (Figure 1).

Physical Description

Gallatin Steam Plant is situated in north-central Tennessee on the north shore of Old Hickory Reservoir of the Cumberland River (Figure 9). This fossil-fueled plant contains four generating units, with a combined rated capacity of 1250 MW. The intake for the condenser cooling for all four units of the plant is situated near Cumberland River Mile (CuRM) 243.9. The underwater topography of the river near the skimmer wall (Figure 10) reveals depths of about 15 m (50 ft). The cooling water from the river flows to the plant through an intake channel 838 m (2750 ft) long. The channel is separated from the Cumberland River by a skimmer wall, which extends about 9.4 m (31 ft) below the water surface when the reservoir surface elevation is at normal summer levels (elevation 445 ft). The intake channel draws cool water from the lower depths of the Cumberland River through an opening about 5.5 m (18 ft) below the bottom of the skimmer wall and 95 m (310 ft) wide. The condenser cooling water system operates only on an open cooling mode and under design capacity uses 37.4 m³/s (1320 ft³/s) of cooling water.

Old Hickory Reservoir was created by the impoundment of the Cumberland River at Old Hickory Dam (CuRM 216.2). Flows in Old Hickory Reservoir near Gallatin Steam Plant (CuRM 242) are primarily controlled by releases from the hydroelectric plants at Old Hickory Dam; Cordell Hull Dam, which is 114 km (71 miles) upstream from the plant site on the Cumberland River; and Center Hill Dam, 151 km (94 miles) upstream from the Caney Fork River, which is a major tributary of the Cumberland River. The water surface elevation usually varies by about 1 m throughout the year. Minimum elevations (elev. 442 ft) normally occur in the winter, and maximum elevations (elev. 445 ft) occur in the summer.

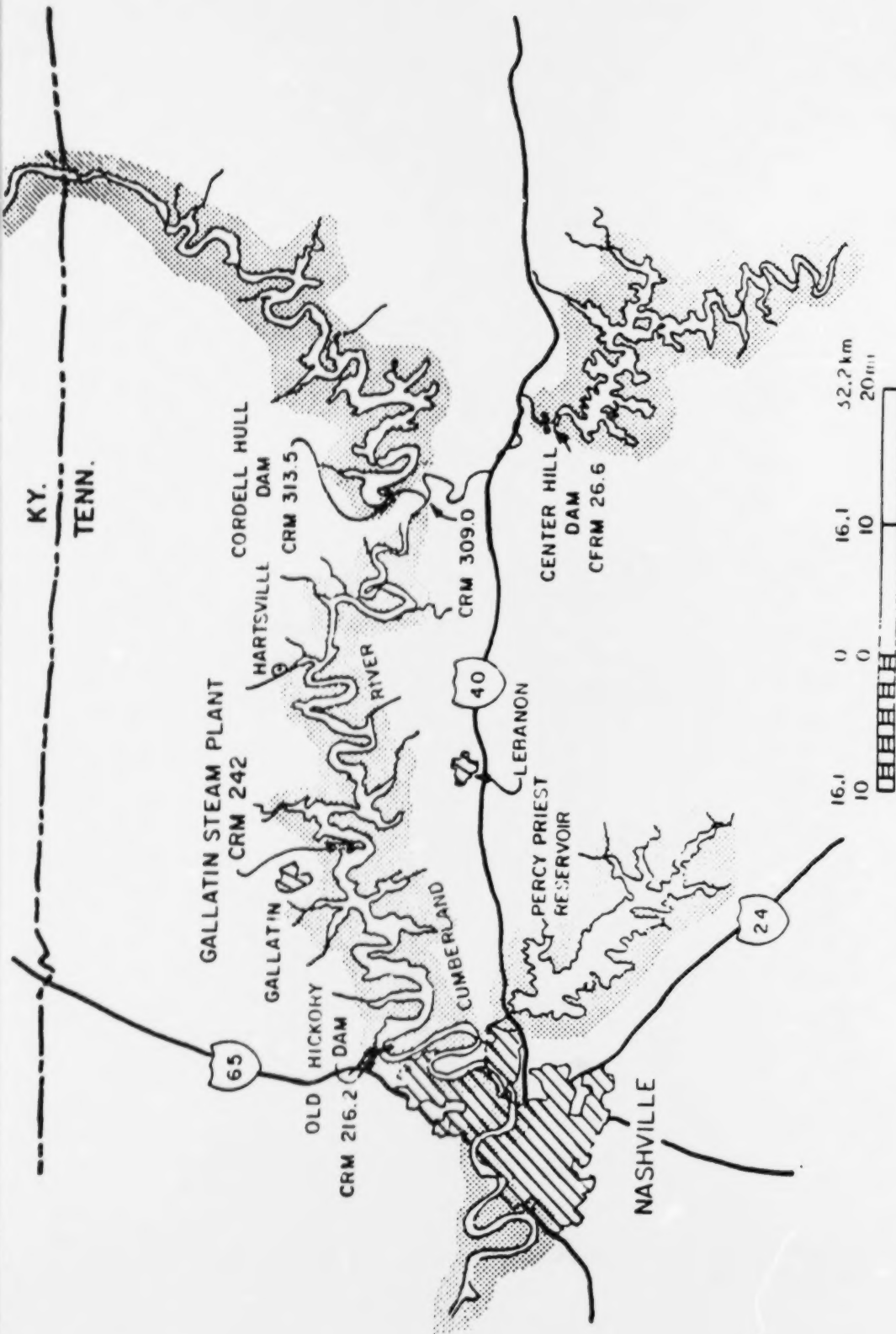


Figure 9. Location map of Gallatin Steam Plant.

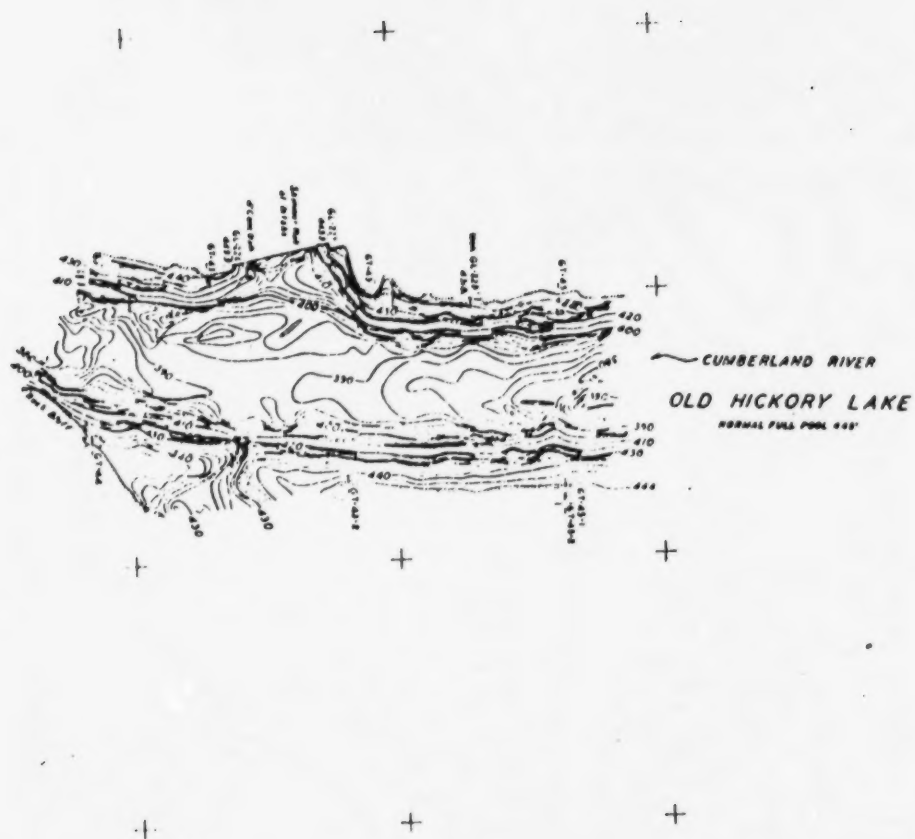


Figure 10. Underwater topography of condenser water intake area at Gallatin Steam Plant.

Specific Study Methods

All studies conducted at Gallatin Steam Plant used sampling from anchored boats. In studies conducted on September 22 and 23, 1976, samples were collected from two points in midchannel, two points at the edge of the channel, two points in front of the skimmer wall, two points 15 m behind the skimmer wall, and two points 90 m behind the skimmer wall (Figure 11). For studies conducted on September 20 and 21, 1977 (a diel study), samples were collected from one point in midchannel, one point in front of the skimmer wall, and two points behind the skimmer wall (Figure 12). The specific methods for these studies are presented in Table 10.

In addition to the biological studies conducted during the diel study on September 20 and 21, 1977, a three-dimensional hydraulic computer model was used to simulate velocity profiles for various reservoir flows that existed during the study period. The results from these computer runs were used to aid in interpretation of the biological data by providing better definition of the source of water drawn into the intake canal.

Studies Conducted on September 22 and 23, 1976

The purposes of these studies were to determine (1) whether the plankton net could be used to determine the vertical distribution of the zooplankton by sampling strata at increasing depths (i.e., 4 m to surface, then 8 m to surface, then 12 m to surface) and subtracting the quantity in the first stratum from that in the second stratum to find the quantity in the second stratum, and so forth; and (2) whether this type of intake minimizes the quantity of zooplankton entrained.

Analyses on the volumes of water filtered by the plankton net show that this technique could not be used to define the vertical distribution of the zooplankton. The shortcomings of the technique arise because the net provides data only for those strata from which water was filtered. If the net becomes clogged and either loses efficiency or stops filtering at some point during retrieval, then the technique of subtracting the number in one stratum from that in the next deeper stratum loses validity. For these studies, filtering efficiency (calculated as the percentage of the water available for filtration that was actually filtered) was found to decrease with increased sampling depth. A linear regression analysis using depth vs. efficiency showed the efficiency of the net to be inversely related to sampling depth (Figure 13). Hence, the technique of subtracting the number in one stratum from the number in the next deeper stratum cannot be used because the technique assumes equal filtration through all strata and this did not occur. However, even though these problems exist, the data from these studies can still provide some information about the quantity of zooplankton entrained, provided caution is taken and only certain data are used, as described below.

Because the organisms in the 4-m-to-surface samples definitely came from that stratum, the data from these samples can be used to determine whether differences existed between sampling points. If these data show that the sampling points in front of the skimmer wall differ from those

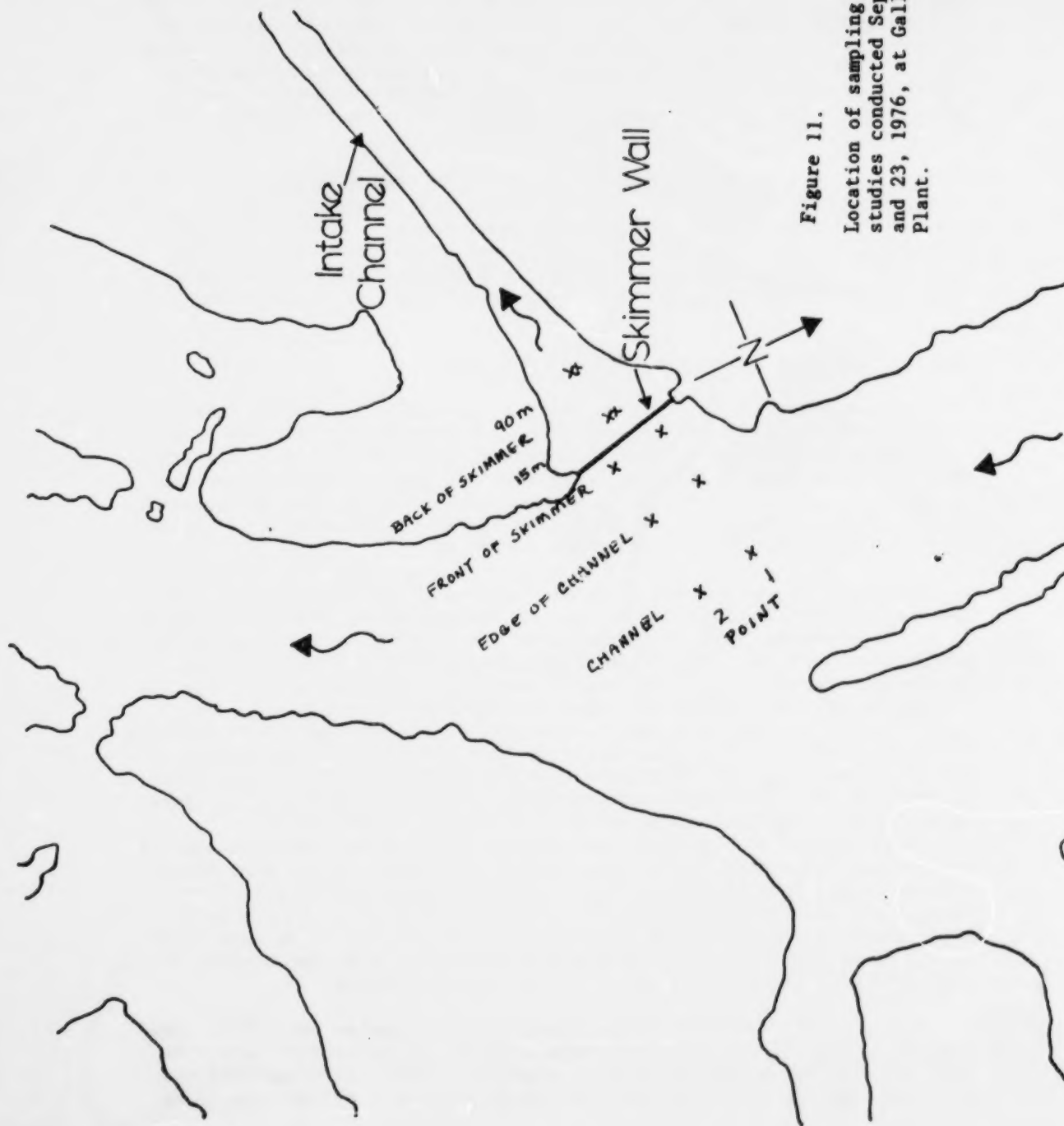


Figure 11.

Location of sampling points for studies conducted September 22 and 23, 1976, at Gallatin Steam Plant.

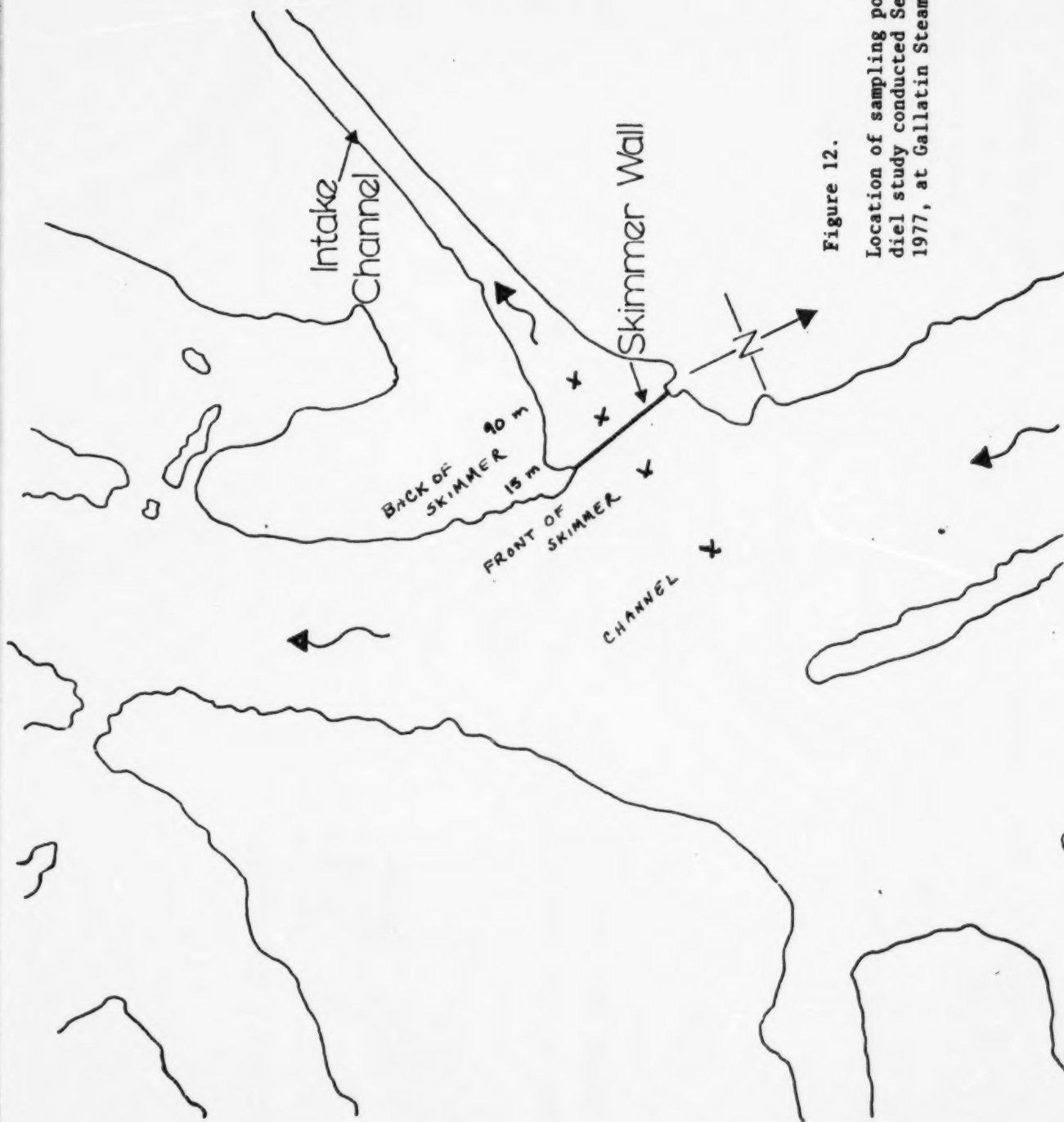


Figure 12.

Location of sampling points for diel study conducted September 20, 1977, at Gallatin Steam Plant.

TABLE 10. SPECIFIC METHODS FOR STUDIES CONDUCTED AT GALLATIN STEAM PLANT INTAKE

Date	Time	Type sampler used	Sampling points	Depths sampled	No. replicates each depth	Laboratory analysis Enumeration Biomass
September 22, 1976	1000-1500	Net	Midchannel	4 m to surface	2	No
				8 m to surface		Yes
				12 m to surface		No
			Front of skimmer	16 m to surface		
				4 m to surface		
				8 m to surface		
September 23, 1976	0900-1300	Net	Back of skimmer --15 m	12 m to surface		
				4 m to surface		
			Back of skimmer --90 m	4 m to surface		
				4 m to surface		
September 20, 1977	0900-1300	Net	(Same as above)		2	Yes
						No
	0600-0700	Trap	Midchannel	0.5, 4, 8, 12, and 16 m	3	Yes
				0.5, 4, 8, and 12 m		No
	0800-0900 1200-1300 1700-1800 1900-2000 2300-2356	Trap	Front of skimmer Back of skimmer --15 m Back of skimmer --90 m (Same as above) (Same as above) (Same as above) (Same as above) (Same as above)	0.5 and 4 m		Yes
				0.5 m		No
					3	Yes
					3	No
					3	No
					3	No
					3	Yes
					3	No

Regression analysis of net efficiency (%)

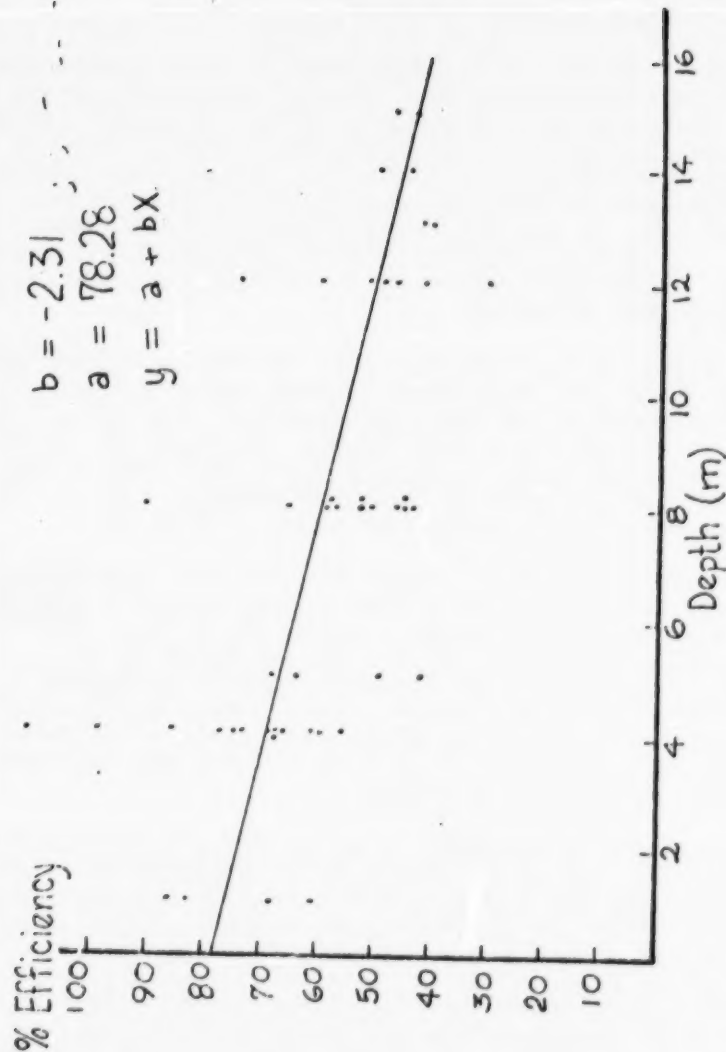


Figure 13. Regression analysis using depth vs. efficiency for volume of water filtered by plankton net during studies conducted September 22 and 23, 1976, at Gallatin Steam Plant.

behind the wall, then the skimmer wall is probably responsible for these differences. Also, if these differences exist, inferences can be made concerning possible causes. That is, if the number behind the skimmer wall is smaller than the number in front, then it can be inferred that the water behind the skimmer did not come from the 4-m-to-surface stratum in front of the skimmer and that the number of organisms in the supplying stratum was smaller than that in the surface stratum. Conversely, if the number is larger, it can be inferred that the water did not come from the 4-m-to-surface stratum and that the supplying stratum contained more organisms than the surface stratum.

Individual sample set data from this stratum for these studies are presented in Appendix D (enumeration data for total zooplankton, group number, and the numerically dominant category within each group). Sample collection and processing precision are summarized in this appendix by using means, standard deviations, and coefficients of variation. Examination of the coefficients of variation shows that the Cladocera and Cyclopoida were the only two taxonomic categories in which less than three-fourths of the sample sets had coefficients of variation below 40 percent. Therefore, statistical tests were not performed on these groups, but were run on the other categories.

The data in Appendix D show Rotifera to be the numerically dominant zooplankton group. Hence, trends observed in total zooplankton are essentially those reflected by the Rotifera; trends in other groups had only a slight bearing on changes in total number. Likewise, the data in Appendix D show that trends in each group are essentially those of the numerically dominant taxonomic category within that group (e.g., for Rotifera, Synchaeta spp.; and for Calanoida, immature calanoids).

Statistical analysis of the data shows that the total zooplankton and Rotifera numbers were significantly lower at sampling points behind the skimmer wall than at the other sampling points (Table 11). This table also shows that no trends were evident for the Calanoida and nauplii. The data in Appendix D show a greater number of Cyclopoida at sampling points behind the skimmer than at those in front on both study days and a greater number of Cladocera behind the skimmer on one study day, but these were not tested statistically because too many data sets had high variability among replicate samples.

The studies conducted on September 22 and 23, 1976, at Gallatin Steam Plant indicate that the plankton net should not be used to determine vertical distribution of the zooplankton, except in water bodies where there is little potential for the net to clog. These studies indicated that, on the basis of inferences from selected samples, Rotifera were positioned near the surface of the water column. Thus, at plants with this type of intake, only small portions of the Rotifera populations have the potential to be entrained. Also, Cyclopoida were apparently positioned near the bottom of the water column so that, at plants with withdrawals near the bottom such as this, they have a great potential for being entrained.

TABLE 11 (continued)

		Station rank for SNK ^a									
		<u>Lowest</u>								<u>Highest</u>	
		<u>Nauplii</u>									
September 22, 1976 ^{b,c}		8	9	10	7	2	4	6	3	5	1
TDF	- 9										
EDF	- 10										
Calculated F	- 4.07										
Tabular F	- 3.02										
September 23, 1976 ^{b,c}		4	2	7	10	9	8	1	6	3	5
TDF	- 9										
EDF	- 10										
Calculated F	- 3.60										
Tabular F	- 3.02										

^a Station number: 1 = channel, point 1
 2 = channel, point 2
 3 = edge of channel, point 1
 4 = edge of channel, point 2
 5 = front of skimmer, point 1
 6 = front of skimmer, point 2
 7 = behind skimmer, 15 m, point 1
 8 = behind skimmer, 15 m, point 2
 9 = behind skimmer, 90 m, point 1
 10 = behind skimmer, 90 m, point 2

^b Abbreviations: TDF = treatment degrees freedom; EDF = error degrees freedom; tabular F = at 0.05 level.

^c Data were heteroscedastic.

Studies Conducted on September 20, 1977 (Diel Study)

The purpose of these studies was to determine the quantity of zooplankton entrained and to determine whether this quantity fluctuates with time of day over a 24-h period. Weather conditions during the study period were partly cloudy, with air temperature ranging from 21 to 29°C. The cycle of sunlight during the diel study and a summary of individual sampling times are presented in Figure 14. This figure shows that periods of partial cloud coverage were frequent, but never lasted very long.

Temperature, dissolved oxygen (DO), pH, and conductivity data for each sampling depth at each sampling time are presented in Table 12. These data show stratified temperature, DO, and pH (during daylight) at both sampling points in front of the skimmer wall. These parameters at the sampling points behind the skimmer were similar to those at the lower depths in front of the skimmer. These data also show a rather large drop in surface water temperature between the noon and the before-sunset sampling periods. This is the opposite of the expected warming that should have occurred during the period of greatest solar heating. This decrease was apparently caused by an increased reservoir flow, which increased the turbulence level and downstream momentum enough to destroy the thermal stratification.

Results of the hydrological computer model runs are presented in a report prepared by TVA, Division of Water Management, "Three-Dimensional Flow Patterns Near the Submerged Intake of Gallatin Steam Plant." A copy of this report is presented as Appendix E.

Information summarized in this report shows that flow in the Cumberland River was very unsteady during the diel study because of the unsteady operation of the hydroelectric plants upstream and downstream. A one-dimensional, flow-routing computer model indicated that flows ranged between 17 and 540 m³/s (600 and 19,000 ft³/s). However, the flows reached temporary plateaus at 110, 220, and 510 m³/s (4000, 8000, and 18,000 ft³/s). These plateaus generally coincided with biological sampling periods. Hence, the 3-dimensional flow patterns at these flow rates were analyzed as quasi-steady-state conditions with a finite difference computer model of the intake channel, the skimmer wall, and the river near the plant.

Results from the computer model showed a quiescent zone near the surface of the intake immediately behind the skimmer wall and on the upstream end (Figures 15 and 16). Although biological sampling was not conducted in this region, biological sampling in such a zone could produce anomalies for the low and nominal flow cases. At the higher river flow condition, the downstream momentum of the river caused sufficient turbulence to disrupt the quiescent zone behind the skimmer wall.

At low river flows, the model indicated there was a strong tendency to entrain water from the upper layers of the reservoir, but as flows increased, only water from the lower strata was entrained. At higher river flows, some of the downstream momentum of the river was retained as water passed under the skimmer wall and forced most of the flow in the intake channel along the downstream bank.

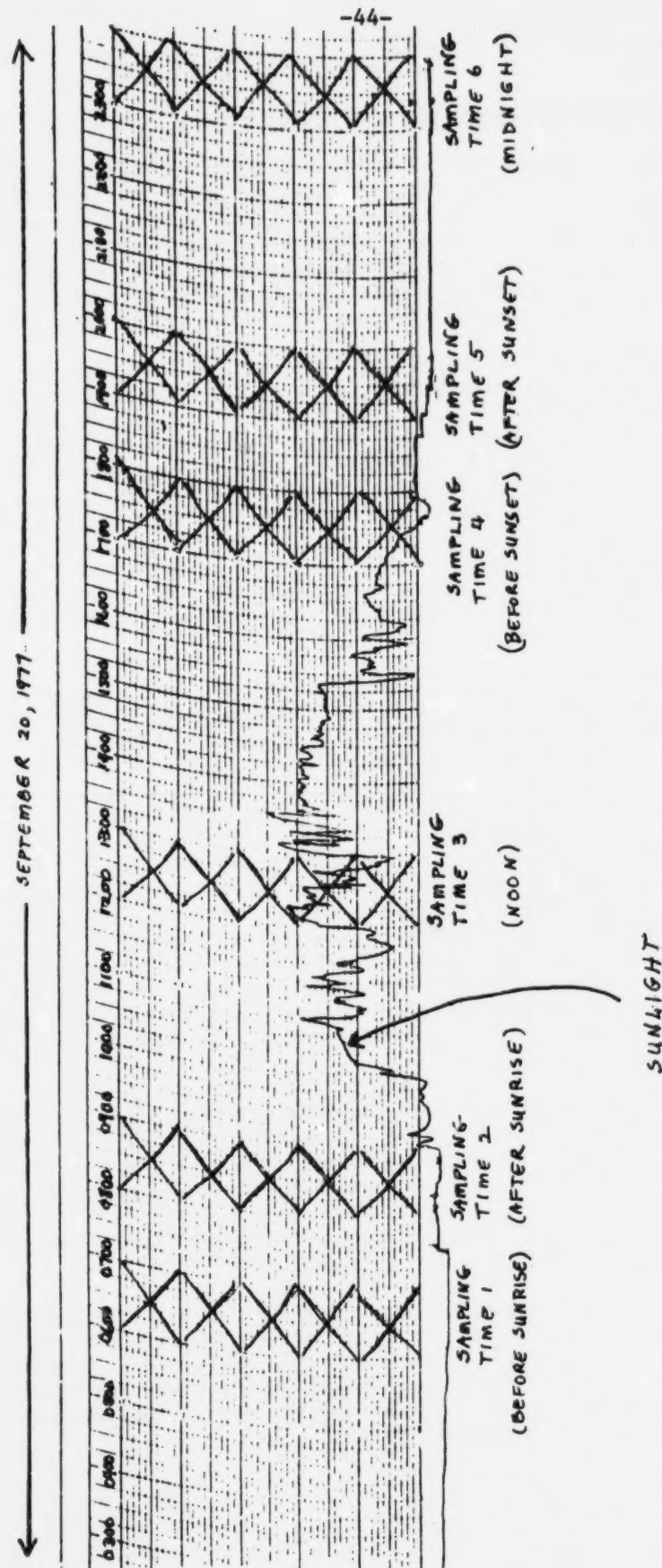


Figure 14. Cycle of sunlight during diel study conducted September 20 and 21, 1977, at Gallatin Steam Plant. Individual sampling times using military notation are shown.

TABLE 12. TEMPERATURE, DISSOLVED OXYGEN, pH, AND CONDUCTIVITY FOR EACH SAMPLING POINT, DEPTH, AND TIME
FOR DIEL STUDY CONDUCTED ON SEPTEMBER 20, 1977, AT GALLATIN STEAM PLANT

Sampling depth (m)	Midchannel			Front of skimmer			Back of skimmer--15 m			Back of skimmer--90 m		
	Temp	DO	pH	Temp	DO	pH	Temp	DO	pH	Temp	DO	pH
Before sunrise												
0	26.0	7.3	7.2	24.5	6.9	7.3	21.9	6.8	7.3	21.6	6.8	7.3
4	22.5	6.6	7.3	22.5	6.6	7.3	21.5	6.0	7.2	-	-	-
8	22.0	6.1	7.2	21.5	5.8	7.2	-	-	-	-	-	-
12	21.5	5.8	7.2	21.5	5.8	7.2	-	-	-	-	-	-
16	21.5	5.8	7.2	-	-	-	-	-	-	-	-	-
After sunrise												
0	26.0	6.9	7.3	25.3	6.8	7.3	21.8	6.2	7.2	21.8	6.4	7.2
4	22.7	6.4	7.3	22.7	6.3	7.3	21.4	5.8	7.1	-	-	-
8	21.6	6.0	7.2	21.6	5.7	7.2	-	-	-	-	-	-
12	21.5	5.8	7.2	21.5	5.7	7.2	-	-	-	-	-	-
16	21.5	5.7	7.2	-	-	-	-	-	-	-	-	-
Noon												
0	26.4	8.2	7.9	26.9	8.9	8.1	21.9	5.9	7.2	21.9	6.0	7.1
4	22.9	8.0	7.3	22.9	5.9	7.2	21.5	5.7	7.1	-	-	-
8	21.6	5.8	7.2	21.6	5.1	7.2	-	-	-	-	-	-
12	21.5	5.7	7.1	21.5	5.6	7.1	-	-	-	-	-	-
16	21.4	5.8	7.1	-	-	-	-	-	-	-	-	-
Before sunset												
0	23.4	8.6	8.0	23.9	8.5	7.9	21.6	6.3	7.1	21.8	6.0	7.2
4	22.0	6.3	7.3	22.0	6.4	7.3	21.6	6.0	7.1	-	-	-
8	21.6	5.7	7.1	21.8	5.9	7.2	-	-	-	-	-	-
12	21.5	5.7	7.1	21.6	5.7	7.1	-	-	-	-	-	-
16	21.5	5.7	7.1	-	-	-	-	-	-	-	-	-

TABLE 12 (continued)

Sampling depth (m)	Midchannel			Front of skimmer			Back of skimmer--15 m			Back of skimmer--90 m		
	Temp	DO	pH	Temp	DO	pH	Temp	DO	pH	Temp	DO	pH
<u>After sunset</u>												
0	22.8	7.6	7.5	23.0	7.6	7.6	21.9	6.4	7.2	22.0	6.1	7.2
4	22.3	6.2	7.2	22.3	6.4	7.3	21.9	5.9	7.2	-	-	-
8	22.1	5.9	7.2	21.9	5.8	7.2	-	-	-	-	-	-
12	21.9	5.6	7.1	21.3	5.6	7.2	-	-	-	-	-	-
16	21.7	5.6	7.1	-	-	-	-	-	-	-	-	-
<u>Midnight</u>												
0	22.5	6.8	7.4	22.2	6.3	7.2	22.1	6.5	7.2	22.1	6.2	7.2
4	22.3	5.8	7.2	22.2	6.1	7.2	22.1	6.1	7.2	-	-	-
8	22.1	5.7	7.1	22.1	5.8	7.2	-	-	-	-	-	-
12	22.1	5.5	7.1	22.0	5.5	7.1	-	-	-	-	-	-
16	22.1	5.5	7.1	-	-	-	-	-	-	-	-	-

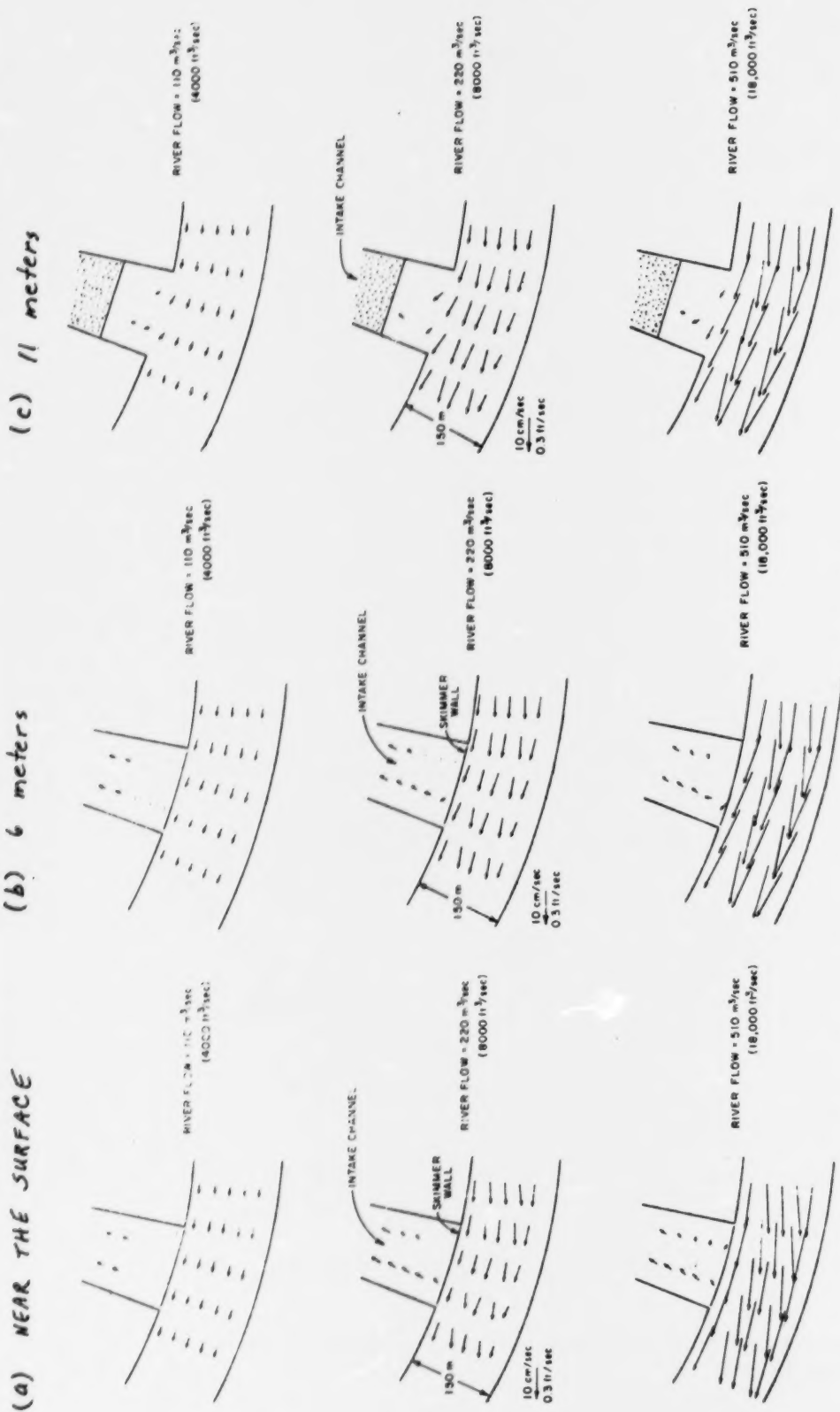
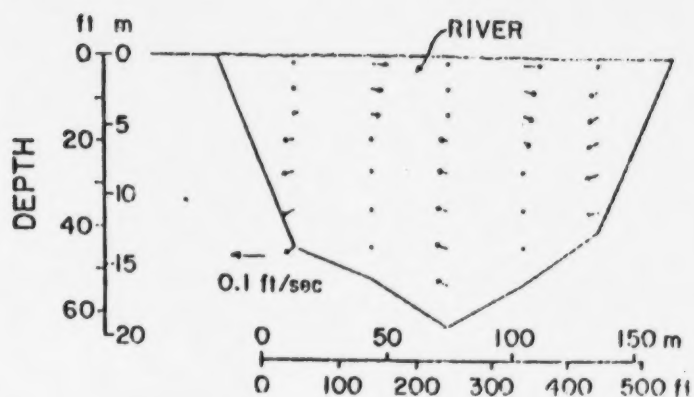
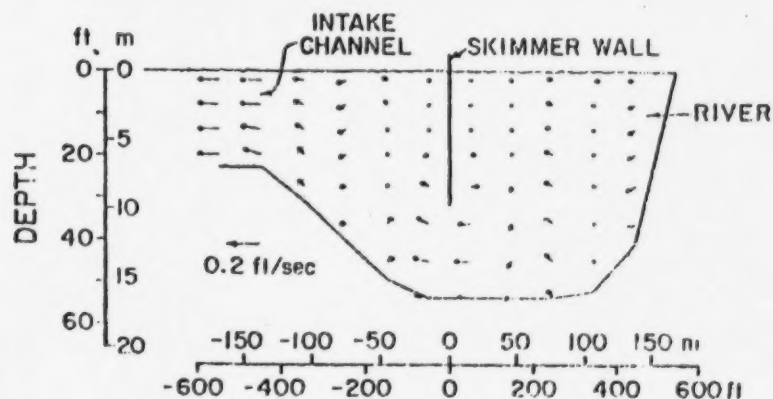


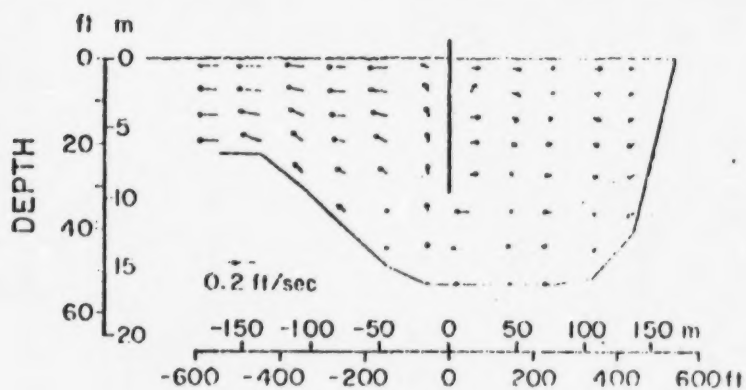
Figure 15. Plan view of velocity vectors near the intake of Gallatin Steam Plant at (a) surface, (b) 6-m depth, and (c) 11-m depth.



FORTY METERS UPSTREAM OF SKIMMER WALL.



UPSTREAM SIDE OF INTAKE CHANNEL



DOWNSTREAM SIDE OF INTAKE CHANNEL

Figure 16. End view of velocity vectors near the intake of Gallatin Steam Plant.

Individual sample set data for these studies are presented in Appendix F (enumeration data for total zooplankton number, group number, and the numerically dominant category within each group). Sample collection and processing precision are summarized in this appendix by using means, standard deviations, and coefficients of variation. Examination of the coefficients of variation shows that the sample sets for each taxonomic category were highly variable. Generally, no more than two-thirds of the sample sets for each category had coefficients of variation below 40 percent. Because of this high variability, statistical tests could not be run, and the data could be used only to identify possible trends.

Spatial and temporal distribution of total zooplankton, Rotifera, Cladocera, Calanoida, and Cyclopoida, are shown in Figures 17 through 21, respectively. For each category the data are expressed as the proportion of each mean to the largest mean, after square root transformation. These figures show that the trends in total number were essentially those of the numerically dominant group, the Rotifera (Appendix F). The data in Appendix F show that the trends in each group were those of the numerically dominant species or category within each group. Hence, since Brachionus angularis was the dominant rotifer, and the Rotifera was the dominant group, then trends in total zooplankton number are those reflected by B. angularis. Figures 17 and 18 show this to be the case, whereas the other figures show that trends in the other groups had little influence on total number. Therefore, each group, other than Rotifera, must be discussed separately from total zooplankton.

Figures 17 and 18 indicate that the smallest numbers for total zooplankton, Rotifera, and B. angularis were found in the midchannel, regardless of depth or time, and that the highest numbers were generally found at the sampling point in front of the skimmer wall, especially at 4 and 8 m. These figures also show that the numbers at many of the sampling points showed a slight trend toward higher numbers during daylight sampling times, regardless of depth. The numbers behind the skimmer were similar to those found at the 12-m sampling depth from the sampling point in front of the skimmer wall. Because this stratum was rich in Rotifera, no minimization of the quantity entrained was apparent.

The numbers of Cladocera and B. longirostris were generally lower at the 0.5-m sampling depth in midchannel (Figure 19). Trends toward higher numbers were vague, but the 8-m stratum at the sampling points in the midchannel and in front of the skimmer seemed to have the greatest numbers. The most apparent trend in day vs. night sampling times was that greater numbers were collected at night than during the day at the 0.5-m depth in the midchannel and in front of the skimmer, indicating that some vertical migration might have occurred. Although the 4-m stratum at the sampling point located about 15 m behind the skimmer wall shows that lower numbers were collected during the day than at night, this difference is not believed to result from vertical migration because no other sampling points behind or immediately in front of the skimmer showed this trend. The numbers of Cladocera and B. longirostris behind the skimmer wall were generally similar to but slightly lower than those in the 12-m stratum in front of the skimmer. Hence, it does not appear that the quantity of cladocerans and B. longirostris entrained into the intake canal was minimized.

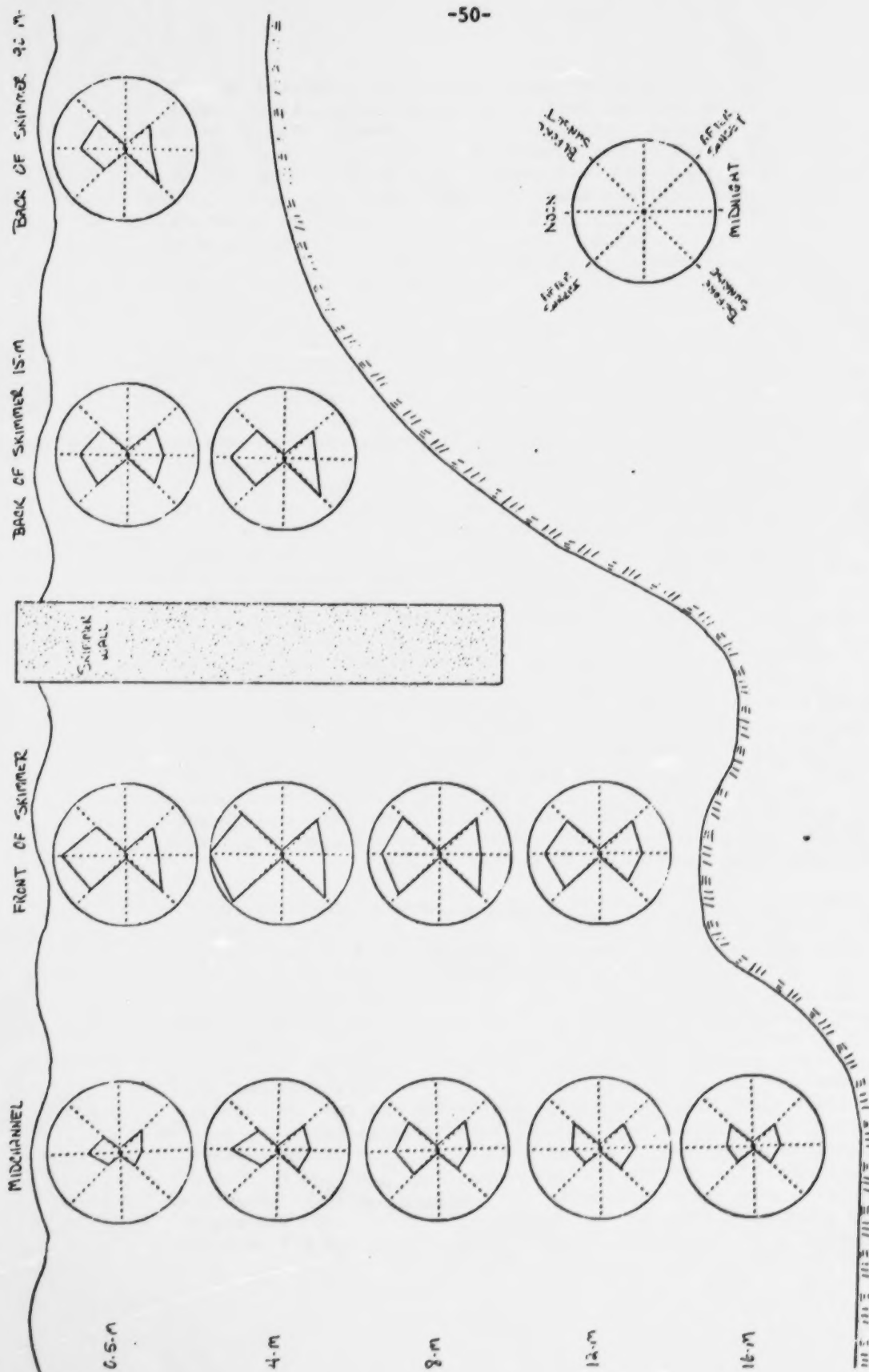


Figure 17. Diel enumeration data for total zooplankton for each sampling depth at each sampling point, Gallatin Steam Plant, September 20, 1977. Data are presented as the proportion of the largest mean number. Inset shows sampling times; data above the horizontal line in each circle are for daylight sampling times, whereas data below the line are for night sampling times.

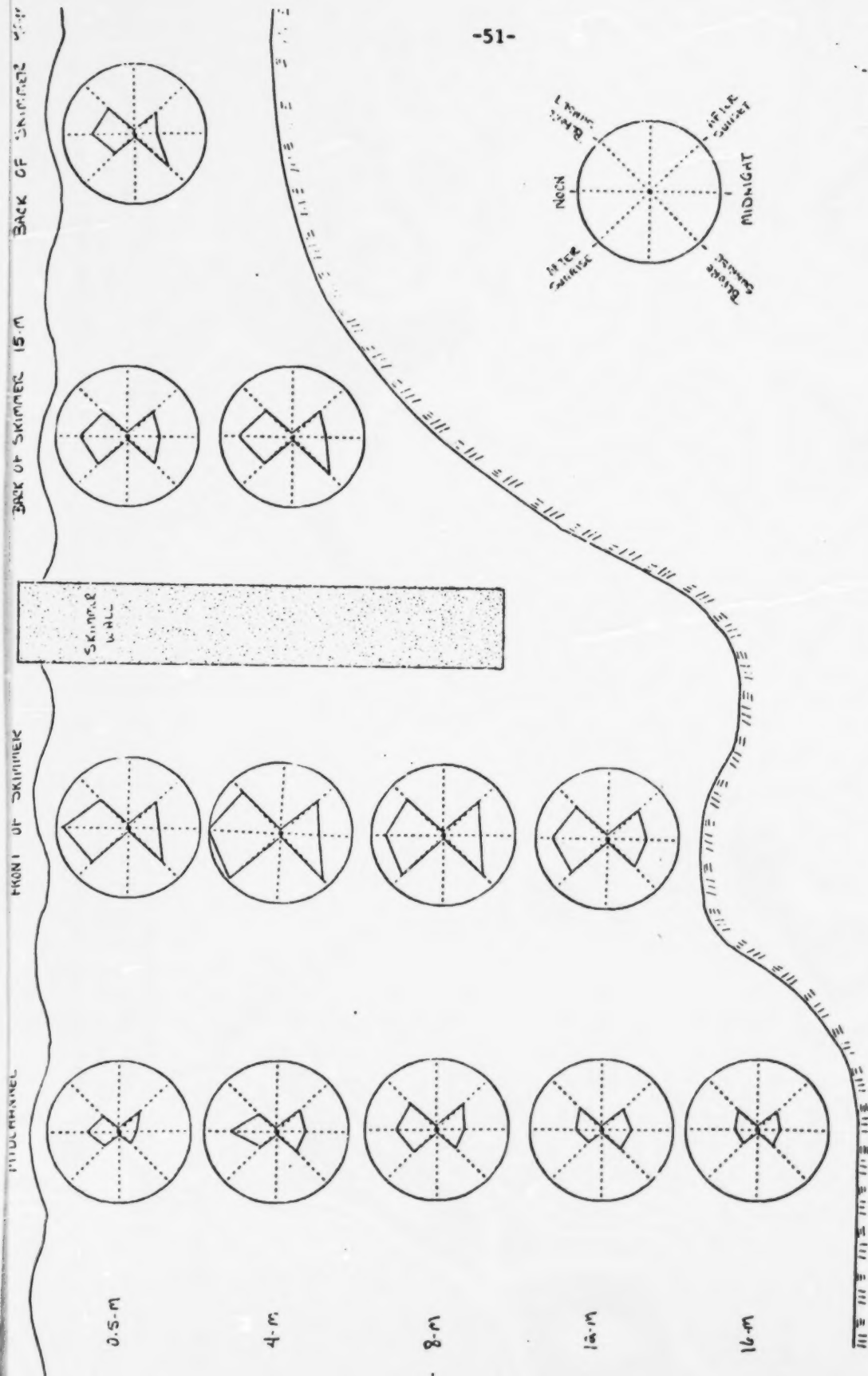


Figure 18. Diel enumeration data for Rotifera for each sampling depth at each sampling point, Gallatin Steam Plant, September 20, 1977. Data are presented as the proportion of the largest mean number. Inset shows sampling times; data above the horizontal line in each circle are for daylight sampling times, whereas data below this line are for night sampling times.

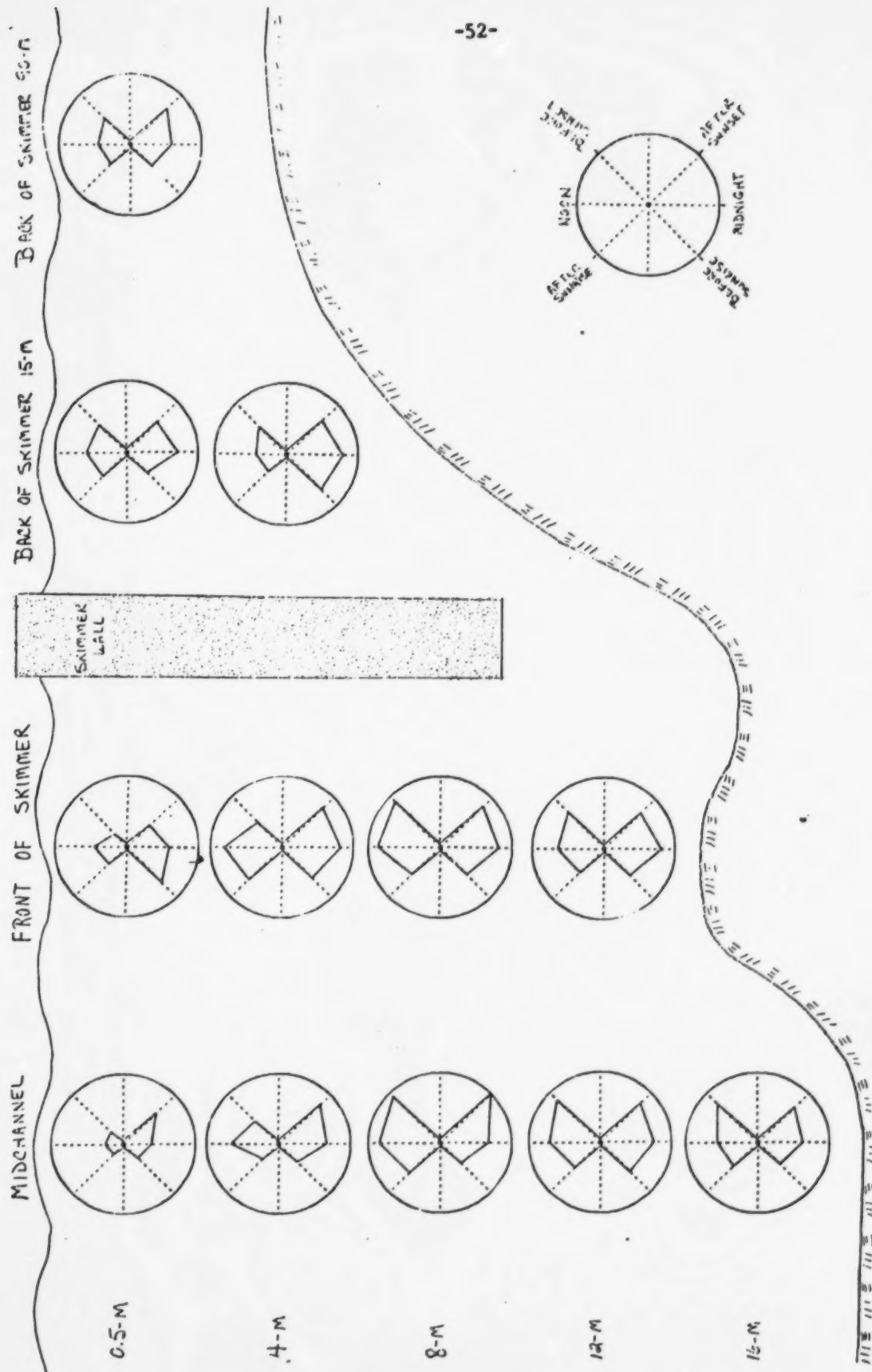


Figure 19. Diel enumeration data for Cladocera for each sampling depth at each sampling point, Gallatin Steam Plant, September 20, 1977. Data are presented as the proportion of the largest mean number. Inset shows sampling times; data above the horizontal line in each circle are for daylight sampling times, whereas data below the line are for night sampling times.

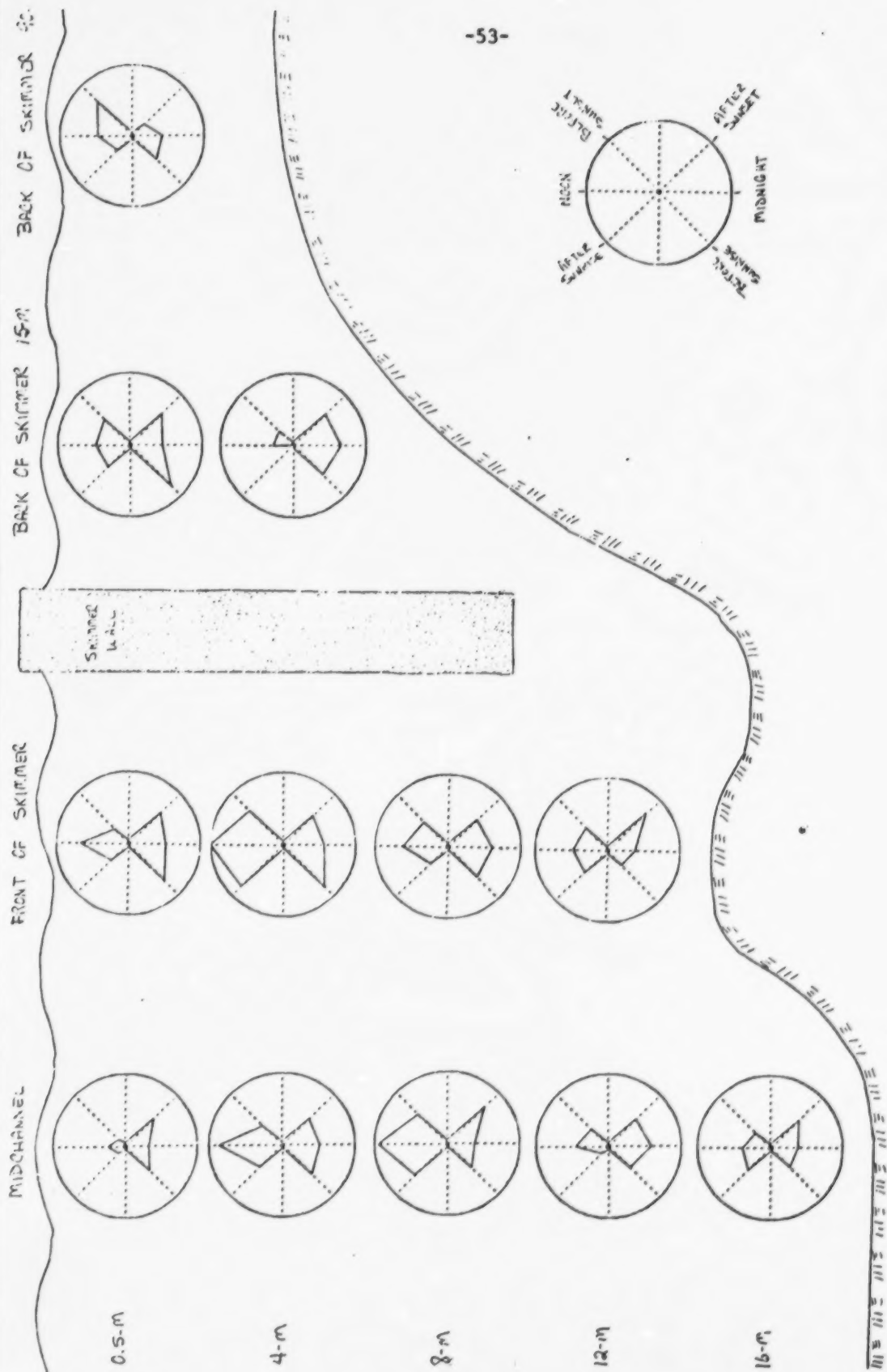


Figure 20. Diel enumeration data for Calanoida for each sampling depth at each sampling point, Gallatin Steam Plant, September 20, 1977. Data are presented as the proportion of the largest mean number. Inset shows sampling times; data above the horizontal line in each circle are for daylight sampling times, whereas data below the line are for night sampling times.

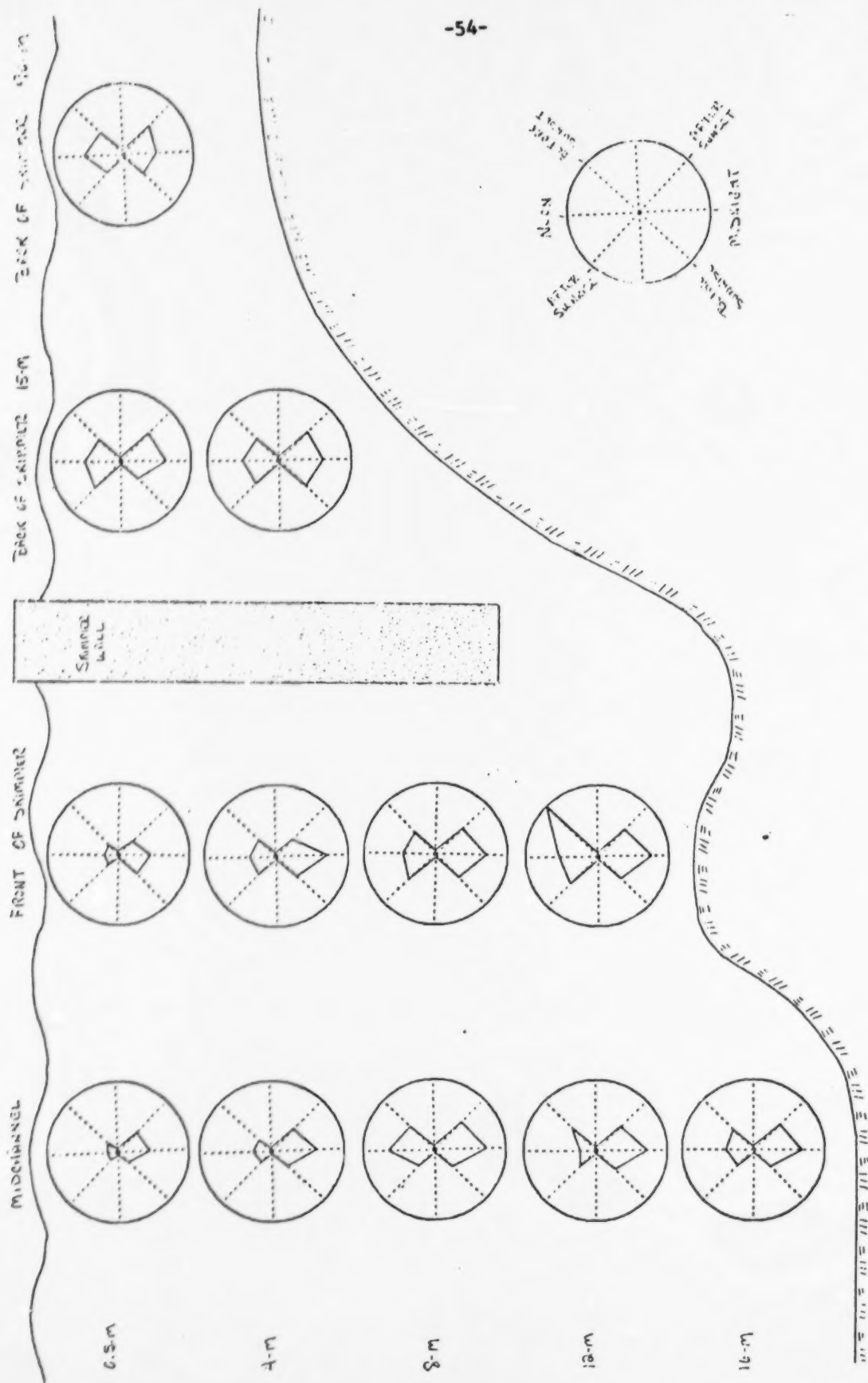


Figure 21. Diel enumeration data for Cyclopoida for each sampling depth at each sampling point, Gallatin Steam Plant, September 20, 1977. Data are presented as the proportion of the largest mean number. Inset shows sampling times; data above the horizontal line in each circle are for daylight sampling times, whereas data below the line are for night sampling times.

The copepods (i.e., the Calanoida, immature calanoids, Cyclopoida, immature cyclopoids, and nauplii) generally showed trends similar to those of the Cladocera in that lower numbers were collected in midchannel from the 0.5-m stratum, and higher numbers were collected from midchannel and in front of the skimmer at 4- and 8-m strata (Figures 20 and 21). The Calanoida, immature calanoids, and nauplii showed no definite trends between day and night sampling times that could be tied to vertical migration. The Cyclopoida and immature cyclopoids showed a trend toward higher numbers during the night in the upper strata (i.e., 0.5- and 4-m) in midchannel and in front of the skimmer wall, indicating vertical migration. For these taxa the numbers behind the skimmer wall were generally similar to those at the 12-m sampling depth in front of the skimmer. Because these organisms were relatively abundant at this stratum, the quantity of copepods entrained was not minimized.

The data from the diel study conducted on September 20, 1977, were highly variable. When graphed, these data indicated that the quantity of zooplankton entrained apparently was not minimized and that it probably depended on the amount in the source water body at the supplying stratum. This study indicates that the number of Cladocera, Calanoida, and Cyclopoida was greater in the supplying stratum than in the upper strata, thus making the number in the intake canal higher than that in the upper strata outside the intake. These data also indicated that the quantity of zooplankton entrained probably did not fluctuate with time from daylight to dark, apparently because the quantity in the supplying stratum did not fluctuate with time.

Summary of Studies Conducted at Intake Type B--Gallatin Steam Plant

The studies conducted at intake type B must be used with discretion because of problems with sampling gear in one series of studies and because of high variability between many sets of replicate samples in the other series of studies. In general, these studies indicated that the quantity of zooplankton entrained may not be minimized by this type of intake. These studies also provided some evidence that the quantity of crustacean zooplankton entrained might have been high at this type of intake because the cooling water is withdrawn from the lower strata, which were richer in crustaceans than the upper strata.

STUDIES AT INTAKE TYPE C

Colbert Steam Plant was selected as the study site for intake type C (Figure 1).

Physical Description

Colbert Steam Plant is situated in northwestern Alabama on Pickwick Reservoir of the Tennessee River (Figure 22). This fossil-fueled plant contains five generating units. The four small units (1 through 4) have a combined rated capacity of 846 MW, and the larger and newer unit 5 has



Figure 22. Location map of Colbert Steam Plant.

a rated capacity of 550 MW. The intake for the circulating cooling water for all five units of the plant is situated near Tennessee River Mile (TRM) 245.0. The underwater topography near the intake is shown in Figure 23. This figure shows that the depth of the navigation channel of the reservoir is about 9 m (27 ft), whereas the depth in the small, elevated intake canal is about 5 m when the reservoir is at normal summer pool. From the small canal the water is pumped through a tunnel to the powerhouse, where it is supplied to the condensers. The plant operates only on an open cooling mode and under design capacity uses $55.1 \text{ m}^3/\text{s}$ ($1940 \text{ ft}^3/\text{s}$) of cooling water.

The Tennessee River flow at the plant site is controlled primarily by releases from Wilson Dam, which is situated 23.3 km (14.5 miles) upstream. Because of the close proximity of the dam, the water near the intake is usually turbulent.

Specific Study Methods

The study conducted at Colbert Steam Plant used transect sampling of a moving watermass. Samples were collected from two points along the upstream transect--one on the right side of the navigation channel and one on the left side (Figure 24). As the watermass neared the intake, two similarly located points upstream from the intake and two points in the intake canal were sampled. The specific methods for this study are presented in Table 13.

Study Conducted on May 25, 1977

The purposes of this study were to (1) field test the trap sampler, (2) compare the trap sampler with the plankton net, and (3) determine whether this type of intake minimizes the quantity of zooplankton entrained.

Testing of the trap sampler showed that several modifications would be necessary before it could be used to produce satisfactory results. Because of these problems, this study could not be used to compare the results obtained using the trap with those obtained using the plankton net. Therefore, only the samples collected with the plankton net could be used to determine whether this type of intake minimizes the quantity of zooplankton entrained.

Data collected with the plankton net are summarized in Appendix G by using individual data points, means, standard deviations, and coefficients of variation for total zooplankton; group totals; and the numerically dominant category or species within each group. Examination of the coefficients of variation shows that these sample sets were highly variable. Only total zooplankton, Calanoida, and nauplii had more than three-fourths of the sample sets with coefficients of variation below 40 percent. Therefore, statistical tests were not run on the other data.

TENNESSEE RIV.
PICKWICK LAKE
NORMAL FULL POOL 414'



Figure 23. Underwater topography near the Colbert Steam Plant intake.

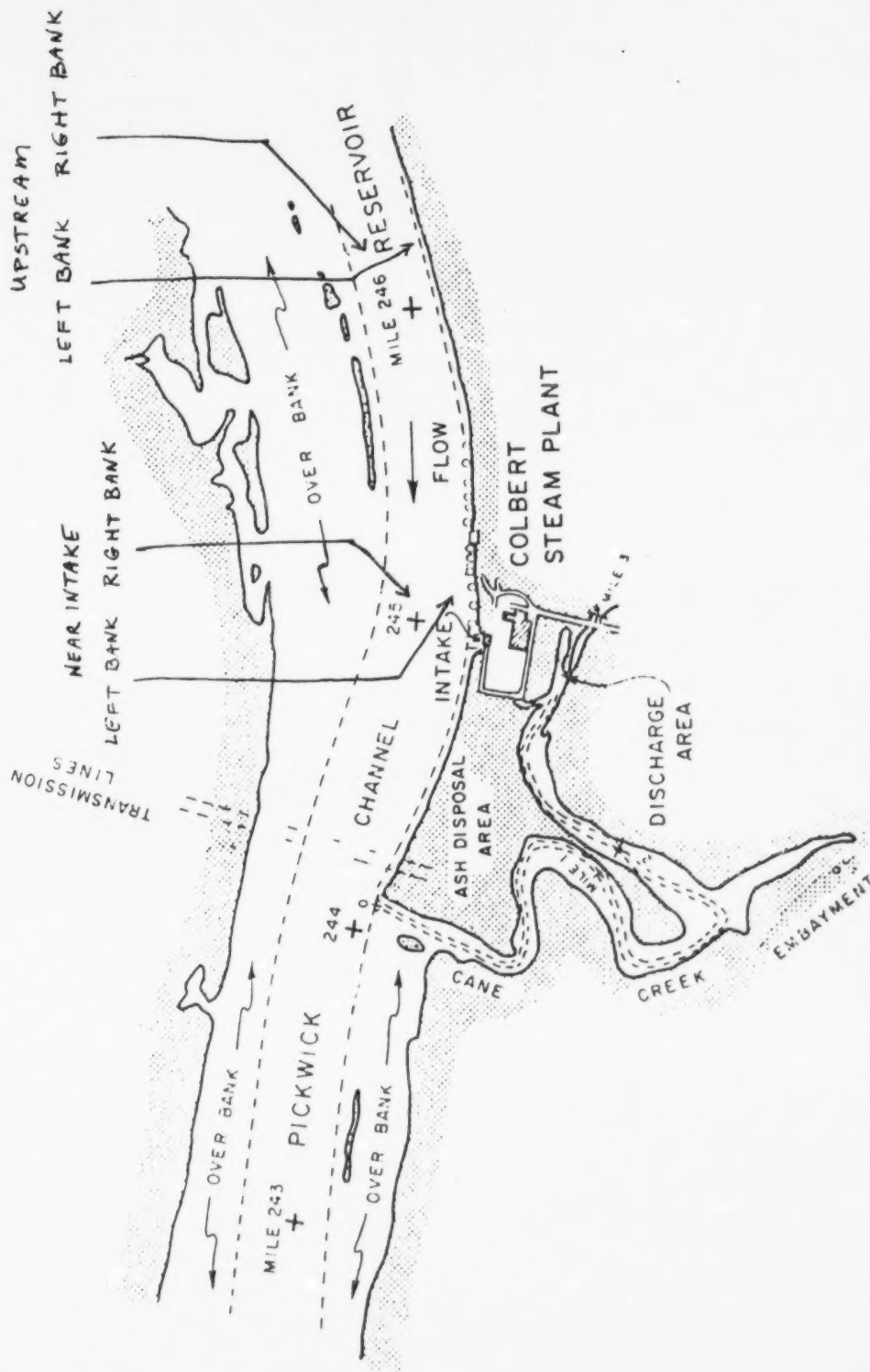


Figure 24. General location of transects and sampling points at Colbert Steam Plant.

TABLE 13. SPECIFIC METHODS FOR STUDIES CONDUCTED AT COLBERT STEAM PLANT INTAKE, MAY 25, 1977

Time	Type sampler used	Sampling points	Depths sampled	No. replicates each depth	Laboratory analysis Enumeration Biomass
1030-1240	Net	Upstream, right and left banks	4 m to surface	2	Yes
			8 m to surface	2	No
		Near intake, right and left banks	4 m to surface	2	Yes
			8 m to surface	2	No
	Trap	Intake	2 m to surface	2	Yes
					No
					No
		Upstream right and left banks	2, 5, and 8 m	3	Yes
				3	Yes
				3	No
		Near intake, right and left banks	2, 5, and 8 m	3	Yes
				3	Yes
				3	No
		Intake	2 m	3	Yes

The data in Appendix G show that the Rotifera numerically dominated the zooplankton community and that the rotifers were most numerous in the 4-m-to-surface samples on the left bank; hence, the numbers of rotifers in the intake forebay were similarly high. The Cladocera, Calanoida, and Cyclopoida were variable and did not show any definite trends. The nauplii appeared to be relatively uniform, regardless of sampling point or depth, and therefore did not show any trends. The statistical tests (i.e., the ANOVA and SNK) show that statistically significant differences in total number, Calanoida, and nauplii could not be tied to the intake structure (Table 14).

Summary of Studies Conducted at Intake Type C--Colbert Steam Plant

These data suggest that this type of intake does not minimize the quantity of zooplankton entrained. However, the study represents only one watermass, and conclusive statements are premature.

STUDIES AT INTAKE TYPE D

The Widows Creek Steam Plant intake for units 7 and 8 is the only shoreline intake in the TVA system. Therefore, this plant would have to be the study site for this type of intake. However, previous studies at this plant have shown that the zooplankton community numbers are low, except for a 1- to 2-week period in May. Because of the short period of desired study conditions, it has not been possible to schedule a field trip at this plant. Hence, no studies have been conducted at intake type D.

TABLE 14. RESULTS OF ANALYSIS OF VARIANCE AND STUDENT, NEWMAN, KEUL'S MULTIPLE RANGE TEST (SNK) DATA COLLECTED ON MAY 25, 1977, AT COLBERT STEAM PLANT

			Station rank for SNK ^a												
			Lowest												Highest
			<u>Total zooplankton</u>												
All data ^b															
TDF	-	9													
EDF	-	10													
Calculated F	-	5.23													
Tabular F	-	2.98													
4 m to surface and intake forebay data ^b															
TDF	-	5													
EDF	-	6													
Calculated F	-	4.77													
Tabular F	-	4.39													
8 m to surface and intake forebay data ^b															
TDF	-	5													
EDF	-	6													
Calculated F	-	3.39													
Tabular F	-	4.39													
			<u>Calanoida</u>												
All data ^{b,c}															
TDF	-	9													
EDF	-	10													
Calculated F	-	3.41													
Tabular F	-	2.98													
4 m to surface and intake forebay data ^{b,c}															
TDF	-	5													
EDF	-	6													
Calculated F	-	3.47													
Tabular F	-	4.39													
8 m to surface and intake forebay data ^{b,c}															
TDF	-	5													
EDF	-	6													
Calculated F	-	5.01													
Tabular F	-	4.39													

TABLE 14 (continued)

Nauplii

All data^{b,c}

TDF	-	9
EDF	-	10
Calculated F	-	2.08
Tabular F	-	2.98

4 m to surface and intake forebay data^{b,c}

TDF	-	5
EDF	-	6
Calculated F	-	1.56
Tabular F	-	4.39

8 m to surface and intake forebay data^b

TDF	-	5
EDF	-	6
Calculated F	-	2.47
Tabular F	-	4.39

Station number: 1a = upstream transect, right bank, 4 m to surface
1b = upstream transect, right bank, 8 m to surface
2a = upstream transect, left bank, 4 m to surface
2b = upstream transect, left bank, 8 m to surface
3a = intake transect, right bank, 4 m to surface
3b = intake transect, right bank, 8 m to surface
4a = intake transect, left bank, 4 m to surface
4b = intake transect, left bank, 8 m to surface
5 = intake forebay, point 1
6 = intake forebay, point 2

Abbreviations: TDF = treatment degrees freedom; EDF = error degrees freedom;
tabular F = 0.05 level.

Data were heteroscedastic.

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GLOSSARY

diel: A complete day (diurnal) and night (nocturnal) cycle.

drogue: A device with lateral fins, which is held in a vertical position by a float and weight. It is used to follow water movement because the fins create drag and thereby move with the current.

heteroscedasticity: A property of data sets where inequality of variances among samples exists.

holoplankton: Organisms that complete their l. $\pm$ cycle while drifting or suspended in the water column.

intake canal: A canal leading from the source water body to the intake pumphouse.

meroplankton: Organisms living only part of their life cycle while suspended in the water column.

overbank: A river's old floodplain, which has been inundated by the construction of a dam.

skimmer wall: A structure which separates the intake canal from the source water by extending to a specified depth in the water column, leaving the lower portion open. A skimmer wall is usually designed to permit selective withdrawal of water from the cooler, lower depths of the water column.

transect: An imaginary line which crosses a water body perpendicular to the flow.

zooplankton: The assemblage of animals suspended in the water column. The freshwater zooplankton typically consists of members of the phyla Ashelminthes (class Rotifera) and Arthropoda (class Crustacea). For purposes of this report, the Rotifera are taxonomically divided at the generic and species levels. However, the Crustacea are discussed as orders and/or suborders as well as genera and species. The Crustacea are divided into the Cladocera and Copepoda, and the Copepoda are subdivided into the Calanoida and Cyclopoida. The larval stage of Copepoda is the nauplius (plural = nauplii).

APPENDIX A

DATA (mg/m³) FOR SAMPLE SETS COLLECTED
MAY 18-JULY 19, 1977, FROM
BROWNS FERRY NUCLEAR PLANT INTAKE AREA

TABLE A.1 (continued)

Watermass sampled ^a	Upstream				Near intake			
	Channel		Overbank		Channel		Dredged channel	
	Point 1	Point 2	Point 1	Point 2	Point 1	Point 2	Point 1	Point 2
Watermass 2								
1	48.1	23.9	35.4	35.4	43.9	41.0	30.7	85.1
2	35.8	45.7	33.8	42.6	61.8	43.6	35.3	55.5
3	46.1	80.2	43.6	46.5	60.1	59.6	23.2	124.1
4	67.7	58.3	37.3	38.2	35.7	76.1	48.6	78.9
5	74.3	71.3	35.0	36.4	46.3	45.5	25.7	34.2
x	54.4	65.9	37.1	39.8	49.6	53.1	32.7	75.6
s	16.0	22.1	3.9	4.6	11.1	14.7	10.1	33.8
c	29.5	39.6	10.5	11.7	22.5	27.7	30.8	44.7
June 8, 1977								
Watermass 1								
1	28.1	27.4	59.6	29.1	84.2	66.4	33.1	24.4
2	41.1	37.8	39.7	25.5	50.2	65.9	61.0	22.1
3	46.6	49.6	36.1	39.8	80.2	69.0	45.0	24.0
4	24.8	52.0	87.2	22.0	80.3	48.4	44.1	30.5
5	35.6	52.7	36.3	29.8	60.3	44.5	34.1	47.7
x	35.2	43.9	51.8	29.2	71.0	58.8	43.5	29.7
s	9.0	11.0	22.0	6.7	15.0	11.5	11.2	10.5
c	25.5	25.1	42.6	22.9	21.0	19.5	25.9	35.4
Watermass 2								
1	47.7		31.3	26.2	49.1	75.6	60.3	134.8
2	39.1	80.1	59.2	63.1	64.2	64.9	69.4	117.9
3	45.1	81.9	35.6	51.0	65.1	100.7	58.9	71.0
4	41.1	96.9	89.5	71.0	38.4	74.6	69.6	85.4
5	68.7	114.5	26.1	54.3	50.7	68.0	115.4	103.0
x	48.3	85.4	48.4	53.1	53.5	76.8	74.7	102.4
s	11.8	24.6	26.3	16.9	11.2	14.1	23.3	25.3
c	24.5	26.3	54.3	31.9	21.0	18.4	31.1	24.7

TABLE A.1 (continued)

Watermass sampled ^a	Upstream				Near intake			
	Channel		Overbank		Channel		Dredged channel	
	Point 1	Point 2	Point 1	Point 2	Point 1	Point 2	Point 1	Point 2
June 9, 1977								
Watermass 1								
1	34.4	84.1	24.7	44.9	22.8	47.1	25.3	31.5
2	23.9	35.7	35.7	63.9	21.5	107.2	37.0	44.0
3	106.8	45.7	29.2	41.1	17.7	70.1	31.0	35.7
4	42.6	60.1	26.0	44.1	23.0	76.3	30.4	35.7
5	23.7	60.7	39.3	39.6	24.7	58.1	36.3	26.9
$\bar{x}$	46.3	57.3	31.0	46.7	21.9	71.8	32.0	34.7
s	34.7	18.3	6.3	9.8	2.6	22.8	4.8	6.3
c	75.0	31.9	20.4	21.0	12.0	31.8	14.9	18.2
								49.8
								48.6
								60.3
								52.4
								71.5
								56.5
								9.5
								16.9

^aNumbers (1,2,3,4,5) indicate replicate number; $\bar{x}$ = mean; s = standard deviation; and c = coefficient of variation ($c = s/\bar{x} \times 100$).

^bSamples not preserved.

^cData lost.

APPENDIX B

DATA (mg/m³) FOR SAMPLE SETS COLLECTED
JULY 20-21, 1977 (DIEL STUDY), FROM
BROWNS FERRY NUCLEAR PLANT INTAKE AREA

TABLE B.1 (continued)

Watermass sampled ^a	Upstream				Near intake			
	Channel		Overbank		Channel		Dredged channel	
	Point 1	Point 2	Point 1	Point 2	Point 1	Point 2	Point 1	Point 2
Watermass 4 (after sunrise)								
1	15.2	14.4	36.9	12.1	25.9	25.6	25.9	21.5
2	12.0	13.9	31.4	25.5	23.6	26.1	27.4	7.2
3	20.7	9.9	31.0	23.1	24.3	26.1	8.5	13.1
4	21.0	16.9	21.3	19.2	20.5	7.3	2.9	9.8
5	23.9	20.3	24.0	17.8	20.5	17.6	12.8	5.9
$\bar{x}$	18.6	15.1	28.9	19.5	23.0	20.5	15.5	11.5
s	4.8	3.9	6.2	5.2	2.4	8.2	10.8	6.2
c	26.1	25.6	21.6	26.5	10.5	40.1	69.8	54.0
Watermass 5 (noon)								
1	29.7	18.7	27.9	17.8	22.5	30.1	25.4	9.4
2	17.7	22.9	31.8	60.1	25.2	32.2	21.3	11.5
3	50.8	24.8	40.1	47.4	39.0	42.2	17.1	42.8
4	21.0	18.5	27.5	41.1	9.5	23.5	23.5	24.5
5	20.3	20.	21.7	8.3	21.1	25.1	16.9	12.8
$\bar{x}$	27.9	21.1	29.8	35.0	23.5	30.6	20.7	20.2
s	13.6	2.7	6.8	21.4	10.6	7.4	4.1	13.9
c	48.6	13.0	22.8	61.2	45.1	24.1	19.7	69.1
Watermass 6 (before sunset)								
1	21.1	13.9	13.9	13.3	24.3	24.3	21.6	19.9
2	16.6	17.8	15.4	12.6	27.6	19.7	19.8	17.7
3	28.5	18.9	20.2	8.3	25.7	34.7	28.8	18.5
4	19.6	18.3	16.1	11.2	10.1	32.1	22.6	11.9
5	19.6	16.0	16.0	16.2	9.1	28.6	38.0	21.3
$\bar{x}$	21.0	16.1	16.3	12.3	19.4	27.9	26.2	16.9
s	4.4	2.0	2.3	2.9	9.0	5.9	7.4	4.0
c	21.1	12.0	14.2	23.2	46.4	21.6	28.5	23.9

^a Numbers (1,2,3,4,5) indicate replicate number; $\bar{x}$ = mean; s = standard deviation; and c = coefficient of variation ($c = s/\bar{x} \times 100$).

^b Samples not preserved.

^c Data lost.

APPENDIX C

DATA (no./m³) FOR SAMPLE SETS COLLECTED
JULY 20-21, 1977 (DIEL STUDY) FROM
BROWNS FERRY NUCLEAR PLANT INTAKE AREA

TABLE C.1. DATA (no. 4.3) FOR SAMPLE SETS COLLECTED JULY 20-21, 1977 (DIEL STUDY),
FERRY BROOKS FERRY NUCLEAR PLANT INTAKE AREA--TOTAL ZOOPLANKTON

Watermass sampled ^a	Upstream				Near intake			
	Channel		Overbank		Channel		Dredged channel	
	Point 1 ^b	Point 2	Point 1 ^b	Point 2	Point 1 ^b	Point 2	Point 1 ^b	Point 2 Intake forebay
July 20, 1977								
Watermass 1 (after sunset)								
1-m depth								
1	55,821		72,569		48,800		67,900	303,600
2	52,691		71,368		51,680		89,100	230,400
3	29,040		74,968		42,100		71,103	184,400
x	45,874		72,968		47,527		76,034	239,467
s	14,666		1,833		4,915		11,428	60,115
c	32.0		2.5		10.3		15.0	25.0
4-m depth								
1	56,426		56,960		100,200		140,766	202,800
2	40,400		88,979		53,627		155,200	206,400
3	43,700		52,293		43,600		151,891	219,200
x	46,842		66,077		65,809		149,286	209,467
s	8,462		19,970		30,202		7,561	8,619
c	18.1		30.2		45.9		5.1	4.1
7-m depth								
1	37,300		c		51,492		99,445	146,800
2	44,800				56,562		87,500	161,600
3	52,960				36,989		78,200	140,400
x	45,020				48,348		88,382	149,600
s	7,832				10,158		10,650	10,874
c	17.4				21.0		12.1	7.3

TABLE C.1 (continued)

Watermass sampled ^a	Upstream			Near intake		
	Channel		Overbank	Channel		Dredged channel
	Point 1 ^b	Point 2	Point 1 ^b	Point 1 ^b	Point 2	Point 1 ^b
July 21, 1977						
Watermass 2 (midnight)						
1-m depth						
1	19,200		36,000	43,700	46,800	59,229
2	19,920		33,040	22,880	32,400	103,800
3	29,200		36,960	45,800	43,100	48,900
$\bar{x}$	22,773		35,333	37,460	40,767	70,643
s	5,577		2,343	12,670	7,478	29,176
c	24.5		5.8	33.8	18.3	41.3
4-m depth						
1	27,920		36,080	42,005	51,400	113,600
2	45,400		70,168	70,080	44,620	48,000
3	39,100		69,767	39,000	238,400	92,600
$\bar{x}$	37,473		58,672	50,362	111,473	84,733
s	8,853		19,566	17,142	109,974	33,500
c	23.6		33.4	34.0	98.7	39.5
7-m depth						
1	21,200		c	29,207	50,840	40,000
2	33,520			86,800	36,240	46,100
3	28,240			35,692	49,800	96,800
$\bar{x}$	27,653			50,566	45,627	60,967
s	6,181			31,546	8,146	31,182
c	22.4			62.4	17.9	51.1

TABLE C.1 (continued)

Watermass sampled ^a	Upstream		Near intake		Intake forebay
	Channel Point 1 ^b	Point 2	Channel Point 1 ^b	Point 2	
Watermass 3 (before sunrise)					
1-m depth					
1	27,200	145,296	40,500	79,784	41,800
2	16,640	161,200	40,600	57,809	105,800
3	42,700	61,440	32,560	45,800	69,031
-x	28,847	122,645	37,887	61,131	72,210
s	13,108	53,599	4,613	17,234	32,118
c	45.4	43.7	12.2	28.2	44.5
4-m depth					
1	35,680	119,174	26,000	38,500	182,000
2	30,320	74,881	32,960	33,100	60,830
3	41,600	68,567	38,600	36,880	104,170
-x	35,867	87,541	32,520	36,160	115,743
s	5,642	27,576	6,312	2,771	61,376
c	15.7	31.5	19.4	7.7	53.0
7-m depth					
1	43,500	c	29,840	59,006	39,800
2	29,600		35,760	38,800	83,800
3	60,694		42,200	42,600	81,600
-x	44,598		35,933	46,802	68,400
s	15,576		6,182	10,783	27,793
c	34.9		17.2	22.9	36.2

TABLE C.1 (continued)

Watermass sampled ^a	Upstream			Near intake		
	Channel		Overbank	Channel		Intake forebay
	Point 1 ^b	Point 2		Point 1 ^b	Point 2	
Watermass 4 (after sunrise)						
1-m depth						
1	31,040		46,400	32,720	61,765	59,630
2	21,600		25,920	51,359	34,560	80,200
3	12,320		42,300	31,200	35,200	46,800
-x	21,653		38,207	38,426	43,842	62,210
s	9,360		10,836	11,226	15,525	16,849
c	43.2		28.4	29.2	35.4	27.1
4-m depth						
1	17,520		27,040	32,720	22,320	88,600
2	23,360		71,901	28,160	20,240	60,430
3	27,760		48,700	40,100	20,240	52,693
-x	22,880		49,214	33,660	20,933	67,241
s	5,137		22,435	6,025	1,201	18,898
c	22.5		45.6	17.9	5.7	28.1
7-m depth						
1	40,900	c		32,480	3,820	70,036
2	18,800			31,440	900	34,480
3	1,900			49,000	39,700	56,561
-x	20,533			37,640	14,807	53,692
s	19,558			9,852	21,608	17,951
c	95.2			26.2	145.9	33.4

TABLE C.1 (continued)

Watermass sampled ^a	Upstream				Near intake			
	Channel		Overbank		Channel		Dredged channel	
	Point 1 ^b	Point 2	Point 1 ^b	Point 2	Point 1 ^b	Point 2	Point 1 ^b	Point 2
Watermass 5								
(noon)								Intake forebay
1-m depth								
1	11,360		44,300		41,500		39,360	49,200
2	4,840		68,433		55,758		29,760	67,200
3	4,620		56,162		22,400		51,100	50,800
x	6,940		56,298		39,886		40,073	55,733
s	3,829		12,067		16,737		10,688	9,963
c	55.2		21.4		42.0		26.7	17.9
4-m depth								
1	12,720		51,487		35,440		31,360	55,628
2	20,620		24,000		28,800		38,960	34,640
3	33,040		22,880		18,640		25,200	59,630
x	22,127		32,789		27,627		31,840	49,966
s	10,243		16,202		8,464		6,893	13,423
c	46.3		49.4		30.6		21.7	26.9
7-m depth								
1	18,480		c		32,160		26,560	64,565
2	24,480				25,680		44,300	63,231
3	28,160				15,200		40,200	60,831
x	23,707				24,347		37,020	62,876
s	4,886				8,558		9,288	1,892
c	20.6				35.2		25.1	3.0

TABLE C.1 (continued)

Watermass sampled ^a	Upstream			Near intake		
	Channel Point 1 ^b	Point 2	Overbank Point 1 ^b	Channel Point 1 ^b	Dredged channel Point 1 ^b	Intake forebay
Watermass 5 (before sunset)						
1-m depth						
1	16,240		46,400	24,800	29,280	63,765
2	16,160		44,200	19,120	68,435	110,600
3	20,960		39,300	25,840	27,680	121,000
$\bar{x}$	17,787		43,300	23,253	41,798	98,455
s	2,748		3,635	3,617	23,082	30,489
c	15.5		8.4	15.6	55.2	31.0
4-m depth						
1	19,200		39,100	38,500	31,920	76,972
2	23,200		33,684	28,560	27,440	107,198
3	25,760		27,240	21,360	76,705	106,400
$\bar{x}$	22,720		33,340	29,473	45,355	96,857
s	3,306		5,937	8,606	27,242	17,225
c	14.6		17.8	29.2	60.1	17.8
7-m depth						
1	13,360	c		18,240	22,160	103,750
2				13,760	19,920	133,798
3	30,240			27,040	20,240	127,414
$\bar{x}$	21,800			19,680	20,773	121,654
s	11,936			6,756	1,212	15,830
c	54.8			34.3	5.8	13.0

^aNumbers (1,2,3) indicate replicate number; $\bar{x}$ = mean; s = standard deviation; and c = coefficient of variation ($c = s/\bar{x} \times 100$).

^bNo samples collected from Point 1 in diel study.

^cNo samples collected from 7-m depth.

^dNo sample collected.

TABLE C.2 (continued)

Watermass sampled ^a	Upstream		Overbank		Channel		Near intake		Intake forebay
	Channel		Point 1 ^b		Point 1 ^b		Dredged channel		
	Point 1 ^b	Point 2	Point 1 ^b	Point 2	Point 1 ^b	Point 2	Point 1 ^b	Point 2	
July 21, 1977									
Watermass 2 (midnight)									
1-m depth									
1	4,560		13,520		26,700		12,800		30,415
2	4,800		10,080		2,240		6,000		61,000
3	2,880		13,360		5,200		9,200		28,600
$\bar{x}$	4,080		12,320		11,380		9,333		40,005
s	1,046		1,942		13,350		3,402		18,205
c	25.6		15.8		117.3		36.5		45.5
4-m depth									
1	3,840		22,000		4,905		21,000		86,200
2	20,200		48,691		31,680		22,900		28,300
3	6,600		40,286		4,700		28,400		58,800
$\bar{x}$	10,213		36,992		13,762		57,433		57,767
s	8,758		13,647		15,518		61,466		28,964
c	85.6		36.9		112.8		107.0		50.1
7-m depth									
1	2,480		c		4,567		27,600		17,900
2	4,800				51,200		10,960		28,800
3	3,840				9,520		12,900		58,200
$\bar{x}$	3,707				21,762		17,153		34,967
s	1,166				25,614		9,099		20,846
c	31.5				117.7		53.0		59.6

TABLE C.2 (continued)

Watermass sampled ^a	Upstream			Near intake		
	Channel		Overbank	Channel		Dredged channel
	Point 1 ^b	Point 2		Point 1 ^b	Point 2	
Watermass 3 (before sunrise)						
1-m depth						
1	2,400		84,779	8,300	13,319	15,400
2	880		93,200	8,100	22,646	49,600
3	2,700		27,520	5,760	7,900	32,608
-x	1,993		68,500	7,387	14,622	32,536
s	976		35,738	1,412	7,459	17,100
c	49.0		52.2	19.1	51.0	52.6
4-m depth						
1	4,720		63,988	2,800	6,600	132,800
2	4,080		40,321	5,200	6,700	26,947
3	5,500		40,421	5,000	8,320	54,400
-x	4,767		48,243	4,333	7,207	71,382
s	711		13,635	1,332	965	54,932
c	14.9		28.3	30.7	13.4	77.0
7-m depth						
1	11,700	c		3,840	22,775	21,200
2	6,160			5,600	11,200	47,000
3	16,140			9,600	13,300	42,600
-x	11,333			6,347	15,758	36,933
s	5,000			2,952	6,167	13,802
c	44.1			46.5	39.1	37.4

TABLE C.2 (continued)

Watermass sampled ^a	Upstream			Near intake		
	Channel		Overbank	Channel		Intake forebay
	Point 1 ^b	Point 2	Point 1 ^b	Point 2	Point 1 ^b	
Watermass 4 (after sunrise)						
1-m depth						
1	5,840		15,700	8,000	22,678	24,946
2	5,680		5,520	21,212	12,480	40,800
3	2,960		12,500	12,960	10,320	19,000
x	4,827		11,240	14,057	15,159	28,249
s	1,619		5,206	6,674	6,600	11,269
c	33.3		46.3	47.5	43.5	39.9
4-m depth						
1	5,440		6,800	9,680	3,680	42,800
2	7,040		18,410	9,360	5,360	23,078
3	8,720		10,700	14,100	3,280	19,743
x	7,067		11,970	11,047	4,107	28,540
s	1,640		5,908	2,649	1,104	12,461
c	23.2		49.4	24.0	26.9	43.7
7-m depth						
1	10,900	c		13,760	900	30,949
2	7,760			14,720	240	17,280
3	320			21,900	8,000	25,479
x	6,327			16,793	3,047	24,569
s	5,434			4,448	4,302	6,880
c	85.9			26.5	141.2	28.0

TABLE C.2 (continued)

Watermass sampled ^a	Upstream			Near intake		
	Channel		Overbank	Channel		Intake forebay
	Point 1 ^b	Point 2		Point 1 ^b	Point 2	
Watermass 5 (noon)						
1-m depth						
1	5,120	27,300		13,900	20,640	27,600
2	2,460	32,149		41,752	16,480	44,300
3	2,960	23,079		5,680	23,900	30,900
x	3,513	27,509		20,444	20,340	34,267
s	1,414	4,539		18,905	3,719	8,844
c	40.2	16.5		92.5	18.3	25.8
4-m depth						
1	1,200	18,541		8,640	11,920	36,818
2	9,360	15,440		10,240	14,720	20,720
3	11,680	12,800		8,320	11,840	38,152
x	7,413	15,594		9,067	12,826	31,897
s	5,505	2,874		1,029	1,640	9,702
c	74.3	18.4		11.3	12.8	30.4
7-m depth						
1	7,920	c		7,040	13,120	39,353
2	10,080			8,800	8,900	45,623
3	10,000			5,280	10,600	36,952
x	9,333			7,040	10,873	40,643
s	1,225			1,760	2,123	4,477
c	13.1			25.0	19.5	11.0

TABLE C.2 (continued)

Watermass sampled ^a	Upstream			Near intake		
	Channel		Overbank	Channel		Intake forebay
	Point 1 ^b	Point 2		Point 1 ^b	Point 2	
Watermass 6 (before sunset)						
1-m depth						
1	9,840		39,400	14,960	18,080	43,755
2	5,120		34,500	10,320	50,825	75,600
3	10,800		32,600	11,760	21,040	81,000
$\bar{x}$	6,050		35,500	12,347	29,982	66,785
s	3,496		3,505	2,375	18,111	20,126
c	57.9		9.9	19.2	60.4	30.1
4-m depth						
1	5,600		21,100	11,000	20,400	53,894
2	12,320		22,780	9,520	8,800	76,342
3	5,840		17,860	5,760	50,025	80,864
$\bar{x}$	7,920		20,580	8,760	26,435	70,367
s	3,812		2,501	2,701	21,226	14,444
c	48.1		12.2	30.8	80.3	20.5
7-m depth:						
1	3,280		c	4,400	10,320	72,894
2	d			3,280	8,400	102,410
3	8,480			6,320	7,440	87,514
$\bar{x}$	5,880			4,667	8,720	87,606
s	3,677			1,537	1,466	14,758
c	62.5			32.9	16.8	16.9

^aNumbers (1,2,3) indicate replicate number; $\bar{x}$ = mean; s = standard deviation; and c = coefficient of variation ($c = s/\bar{x} \times 100$).

^bNo samples collected from Point 1 in diel study.

^cNo samples collected from 7-m depth.

^dNo sample collected.

TABLE C.3. DATA (no./m³) FOR SAMPLE SETS COLLECTED JULY 20-21, 1977 (DIEL STUDY),
FROM BROWNS FERRY NUCLEAR PLANT INTAKE AREA--*Brachionus angularis*

Watermass sampled ^a	Upstream		Overbank Point 1 ^b Point 2	Near intake	
	Channel			Dredged channel	
	Point 1 ^b Point 2	Point 1 ^b Point 2		Point 1 ^b Point 2	Point 1 ^b Point 2
July 20, 1977					
Watermass 1 (after sunset)					
1-m depth					
1	12,673	21,477	6,400	13,473	58,800
2	9,605	22,678	5,594	15,600	52,800
3	5,040	19,476	2,600	15,608	37,200
$\bar{x}$	9,106	21,210	4,865	14,894	49,600
s	3,840	1,618	2,002	1,230	9,973
c	42.2	7.6	41.2	8.3	20.1
4-m depth					
1	5,603	13,340	13,600	35,191	43,600
2	5,100	12,940	2,401	30,400	44,400
3	4,100	12,006	3,000	46,655	42,800
$\bar{x}$	4,934	12,762	6,334	37,415	43,600
s	765	685	6,300	8,353	800
c	15.5	5.4	99.5	22.3	1.8
7-m depth					
1	2,200	c	2,268	9,598	38,800
2	2,100		2,668	2,700	40,400
3	2,935		1,400	14,600	29,100
$\bar{x}$	2,412		2,112	8,966	36,100
s	456		648	5,975	6,115
c	18.9		30.7	66.6	16.9

TABLE C.3 (continued)

Watermass sampled ^a	Upstream			Near intake				
	Channel		Overbank	Channel		Dredged channel		
	Point 1 ^b	Point 2	Point 1 ^b	Point 1 ^b	Point 2	Point 1 ^b	Point 2	Intake forebay
July 21, 1977								
Watermass 2 (midnight)								
1-m depth								
1	640		5,040	400		4,500		5,603
2	880		2,800	640		1,600		16,400
3	880		3,680	1,300		2,000		4,800
x	800		3,840	780		2,700		8,934
s	139		1,129	466		1,572		6,478
c	17.3		29.4	59.7		58.2		72.5
4-m depth								
1	480		6,560	700		1,500		6,800
2	700		13,207	1,280		4,600		6,400
3	700		11,606	400		6,400		10,600
x	627		10,458	793		4,167		7,933
s	127		3,469	447		2,479		2,318
c	20.3		33.2	56.4		59.5		29.2
7-m depth								
1	1,120		c	320		3,900		6,700
2	400			800		1,600		11,800
3	640			720		1,900		16,800
x	720			613		2,467		11,767
s	367			257		1,250		5,050
c	51.0			41.9		50.7		42.9

TABLE C.3 (continued)

Watermass sampled ^a	Upstream			Near intake		
	Channel Point 1 ^b	Point 2	Overbank Point 1 ^b	Channel Point 1 ^b	Dredged channel Point 1 ^b	Intake Point 2 forebay
Watermass 3 (before sunrise)						
1-m depth						
1	560		19,462	3,400	4,928	6,100
2	320		29,200	2,600	5,062	15,000
3	600		8,160	1,680	2,300	7,337
$\bar{x}$	493		18,941	2,560	4,097	9,479
s	151		10,530	861	1,557	4,821
c	30.7		55.6	33.6	38.0	50.9
4-m depth						
1	2,000		20,795	880	2,800	24,000
2	1,840		11,520	2,160	2,100	8,404
3	2,000		14,007	1,700	2,640	16,600
$\bar{x}$	1,947		15,441	1,580	2,513	16,335
s	92		4,801	648	367	7,801
c	4.7		31.1	41.0	14.6	47.8
7-m depth						
1	5,700		c	960	7,592	6,700
2	2,560			2,400	4,900	11,800
3	5,736			3,800	4,600	16,800
$\bar{x}$	4,665			2,387	5,697	11,767
s	1,823			1,420	1,648	5,050
c	39.1			59.5	28.9	42.9

TABLE C.3 (continued)

Watermass sampled ^a	Upstream			Near intake		
	Channel Point 1 ^b	Point 2	Overbank Point 1 ^b	Point 2	Dredged channel Point 1 ^b	Intake Point 2 forebay
Watermass 4 (after sunrise)						
1-m depth						
1	1,200		4,100	2,560	7,204	3,202
2	1,600		1,200	7,204	2,320	9,400
3	720		3,100	2,160	4,560	2,600
x	1,173		2,800	3,975	4,695	5,067
s	441		1,473	2,804	2,445	8,764
c	37.6		52.6	70.5	52.1	74.3
4-m depth						
1	1,440		1,680	2,960	800	8,400
2	1,920		2,801	2,640	1,680	3,202
3	1,760		1,900	4,400	240	3,869
x	1,627		2,127	3,333	907	5,157
s	378		594	938	726	2,828
c	23.2		27.9	28.1	80.1	54.8
7-m depth						
1	3,300		c	3,920	320	5,870
2	1,040			5,600	60	3,440
3	100			7,600	2,700	4,936
x	1,480			5,707	1,027	4,749
s	1,645			1,842	1,455	1,226
c	111.1			32.3	141.7	25.8

TABLE C.3 (continued)

Watermass sampled ^a	Upstream		Near Intake	
	Channel Point 1 ^b	Overbank Point 1 ^b	Channel Point 1 ^b	Dredged channel Point 1 ^b
Watermass 5 (noon)				
1-m depth				
1	1,120	7,000	3,400	5,360
2	600	9,471	2,134	2,640
3	780	7,070	1,360	5,700
x	833	7,847	2,298	4,567
s	264	1,407	1,030	1,677
c	31.7	17.9	44.8	36.7
4-m depth				
1	640	3,335	1,840	2,080
2	3,680	4,960	1,760	1,840
3	1,680	2,560	880	1,600
x	2,000	3,618	1,493	1,840
s	1,545	1,225	533	240
c	77.3	33.9	35.7	13.0
7-m depth				
1	2,080	c	1,440	2,400
2	1,440		1,360	700
3	1,200		720	2,500
x	1,573		1,173	1,867
s	455		395	1,012
c	28.9		33.7	54.2
				16.1

TABLE C.3 (continued)

Watermass sampled ^a	Upstream		Near intake		Intake forebay
	Channel Point 1 ^b	Point 2	Channel Point 1 ^b	Dredged channel Point 1 ^b Point 2	
Watermass 6 (before sunset)					
1-m depth					
1	1,360		2,800	2,640	13,340
2	720	5,100	2,080	11,873	24,400
3	1,920	7,200	2,720	2,240	22,000
-x	1,333	2,700			
s	600	5,000	2,533	5,584	19,913
c	45.0	2,252	395	5,450	5,818
			15.6	97.6	29.2
4-m depth					
1	960	4,000	2,900	3,440	16,141
2	3,120	2,320	2,640	1,120	23,674
3	0	3,840	1,360	14,941	23,142
-x	1,360	3,387	2,300	6,500	20,986
s	1,597	927	824	7,401	4,204
c	117.5	27.4	35.8	113.9	20.0
7-m depth					
1	640		480	1,280	22,620
2	d	c	800	1,040	29,260
3	4,000		1,200	1,120	24,206
-x	2,320		827	1,147	25,362
s	2,375		361	122	3,468
c	102.4		43.7	10.7	13.6

^aNumbers (1,2,3) indicate replicate number; $\bar{x}$ = mean; s = standard deviation; and c = coefficient of variation ($c = s/\bar{x} \times 100$).

^bNo samples collected from Point 1 in diel study.

^cNo samples collected from 7-m depth.

^dNo sample collected.

TABLE C.4. DATA (no./m³) FOR SAMPLE SETS COLLECTED JULY 20-21, 1977 (DIEL STUDY),
FROM BROWNS FERRY NUCLEAR PLANT INTAKE AREA--CLADOCERA

Watermass sampled ^a	Upstream			Near intake		
	Channel		Overbank	Channel		Intake forebay
	Point 1 ^b	Point 2		Point 1 ^b	Point 2	
July 20, 1977						
Watermass 1 (after sunset)						
1-m depth						
1	9,603	4,935		12,000	8,137	69,000
2	12,806	7,202		7,058	19,600	39,600
3	4,640	6,936		9,800	5,338	33,200
-x	9,016	6,358		9,619	11,025	47,267
s	4,114	1,239		2,476	7,557	19,091
c	45.6	19.5		25.7	68.5	40.0
4-m depth						
1	11,740	9,737		16,000	21,595	35,200
2	12,200	17,743		19,076	21,200	32,000
3	11,000	11,206		6,800	20,261	38,800
-x	11,647	12,895		13,959	21,019	35,333
s	605	4,262		6,388	685	3,402
c	6.1	33.1		45.8	3.3	9.6
7-m depth						
1	10,900	c		18,142	25,062	27,200
2	15,700			18,142	21,000	20,000
3	15,747			7,120	15,200	28,500
-x	14,024			14,468	20,421	25,233
s	2,708			6,364	4,956	4,579
c	19.3			44.0	24.3	18.1

TABLE C.4 (continued)

Watermass sampled ^a	Upstream			Near intake		
	Channel		Overbank	Channel		Dredged channel
	Point 1 ^b	Point 2		Point 1 ^b	Point 2	
						Intake forebay
July 21, 1977						
Watermass 2 (midnight)						
1-m depth						
1	7,840		8,560	8,800		11,800
2	6,320		12,000	8,240		12,960
3	14,720		6,960	14,400		15,200
$\bar{x}$	9,627		9,173	10,480		13,320
s	4,476		2,575	3,406		1,728
c	46.5		28.1	32.5		13.0
						37.5
4-m depth						
1	14,480		5,280	17,000		15,100
2	12,600		12,140	17,440		5,520
3	18,100		16,808	14,900		43,200
$\bar{x}$	15,060		11,409	16,447		21,273
s	2,795		5,799	1,357		19,584
c	18.6		50.8	8.3		92.1
						30.4
7-m depth						
1	9,280		c	12,480		16,000
2	13,600			13,000		11,280
3	11,600			10,640		17,600
$\bar{x}$	11,493			12,040		14,960
s	2,162			1,240		3,286
c	18.8			10.3		22.0
						39.9

TABLE C.4 (continued)

Watermass sampled ^a	Upstream				Near intake			
	Channel		Overbank		Channel		Dredged channel	
	Point 1 ^b	Point 2	Point 1 ^b	Point 2	Point 1 ^b	Point 2	Point 1 ^b	Point 2
Intake forebay								
Watermass 3 (before sunrise)								
1-m depth								
1	12,400		38,657		13,500		25,174	8,400
2	7,680		40,000		14,600		18,781	19,800
3	19,900		21,920		9,440		22,500	15,080
x	13,327		33,526		12,513		22,152	14,427
s	6,162		10,073		2,718		3,211	5,728
c	46.2		30.1		21.7		14.5	39.7
4-m depth								
1	15,680		35,191		11,200		19,700	26,000
2	14,640		19,520		11,840		12,900	16,808
3	18,400		13,739		13,700		12,080	28,200
x	16,240		22,816		12,247		14,893	23,669
s	1,942		11,099		1,299		4,183	6,043
c	12.0		48.7		10.6		28.1	25.5
7-m depth								
1	15,400		c		10,480		18,915	9,400
2	13,200				12,560		14,900	18,000
3	23,877				17,000		13,600	14,200
x	17,492				13,347		15,805	13,867
s	5,638				3,330		2,771	4,310
c	32.2				25.0		17.5	31.1

TABLE C.4 (continued)

Watermass sampled ^a	Upstream			Near intake		
	Channel		Overbank	Channel		Intake forebay
	Point 1 ^b	Point 2		Point 1 ^b	Point 2	
Watermass 5 (noon)						
1-m depth						
1	4,320		13,000	15,800	13,040	15,800
2	720		29,748	9,205	8,400	14,200
3	580		29,881	12,480	19,800	14,600
x	1,873		24,209	12,495	13,747	14,867
s	2,120		9,708	3,298	5,723	833
c	113.2		40.1	26.4	41.7	5.6
4-m depth						
1	7,200		23,877	13,680	11,360	12,273
2	4,120		6,400	10,160	17,600	10,000
3	10,960		5,280	7,520	7,840	13,473
x	7,427		11,852	10,453	12,267	11,915
s	3,426		10,429	3,090	4,943	1,764
c	46.1		88.0	29.6	40.3	14.8
7-m depth						
1	5,520		c	14,880	9,680	15,341
2	7,520			7,040	27,300	11,072
3	10,880			4,320	21,300	14,941
x	7,973			8,747	19,427	13,785
s	2,709			5,483	8,958	2,358
c	34.0			62.7	46.1	17.1

TABLE C.4 (continued)

Watermass sampled ^a	Upstream			Near intake		
	Channel		Overbank	Channel		Intake forebay
	Point 1 ^b	Point 2		Point 1 ^b	Point 2	
Watermass 6 (before sunset)						
1-m depth						
1	2,560	13,040		3,920	6,160	10,005
2	7,120	8,400		4,480	8,671	23,800
3	3,920	19,800		7,440	3,600	24,800
-x	4,533	13,747		5,280	6,144	19,535
s	2,341	5,733		1,891	2,536	8,268
c	51.6	41.7		35.8	41.3	42.3
4-m depth						
1	4,160	11,360		13,900	7,200	14,541
2	2,720	17,600		9,360	13,680	18,886
3	8,960	7,840		10,880	14,007	17,024
-x	5,280	12,267		11,380	11,629	16,817
s	3,267	4,943		2,311	3,839	2,180
c	61.9	40.3		20.3	33.0	13.0
7-m depth						
1	2,800	c		7,760	6,880	17,822
2	d			5,600	8,000	18,886
3	7,600			13,520	7,920	23,674
-x	5,200			8,960	7,600	20,127
s	3,394			4,094	625	3,117
c	65.3			45.7	8.2	15.5

^aNumbers (1,2,3) indicate replicate number; $\bar{x}$ = mean; s = standard deviation; and c = coefficient of variation ($c = s/\bar{x} \times 100$).

^bNo samples collected from Point 1 in diel study.

^cNo samples collected from 7-m depth.

^dNo sample collected.

TABLE C.5. DATA (no./m³) FOR SAMPLE SETS COLLECTED JULY 20-21, 1977 (DIEL STUDY),
FROM BROWNS FERRY NUCLEAR PLANT INTAKE AREA--*Diaphanosoma leuchtenbergianum*

Watermass sampled ^a	Upstream			Near intake		
	Channel		Overbank	Channel		Dredged channel
	Point 1 ^b	Point 2	Point 1 ^b Point 2 ^c	Point 1 ^b Point 2	Point 1 ^b Point 2	Point 1 ^b Point 2 forebay
July 20, 1977						
Watermass 1 (after sunset)						
1-m depth						
1	6,537		2,668	10,100		5,870
2	11,472		3,735	5,594		15,000
3	4,080		4,002	8,200		5,203
$\bar{x}$	7,363		3,468	7,965		8,691
s	3,765		706	2,262		5,474
c	51.1		20.4	28.4		63.0
4-m depth						
1	8,671		7,604	13,600		15,463
2	9,100		12,673	16,275		16,400
3	9,400		8,671	5,400		15,729
$\bar{x}$	9,057		9,649	11,758		15,864
s	366		2,672	5,667		483
c	4.0		27.7	48.2		3.0
7-m depth						
1	10,100	d		15,208		20,262
2	13,700			13,740		14,800
3	12,940			5,760		12,600
$\bar{x}$	12,247			11,569		15,887
s	1,898			5,084		3,945
c	15.5			43.9		24.8
						18,467
						4,149
						22.5

TABLE C.5. (continued)

Watermass sampled ^a	Upstream		Near intake	
	Channel		Dredged channel	
	Point 1 ^b	Point 2 ^c	Point 1 ^b	Point 2 ^c
July 21, 1977				
Watermass 2 (midnight)				
1-m depth				
1	6,560	6,880	7,600	10,400
2	5,520	10,000	6,640	11,040
3	13,200	6,560	12,800	12,700
$\bar{x}$	8,427	7,813	9,013	11,380
s	4,166	1,901	3,314	1,187
c	49.4	24.3	36.8	10.4
				39.0
4-m depth				
1	13,360	3,920	15,400	9,600
2	9,800	8,404	15,360	2,800
3	16,300	13,340	13,700	10,000
$\bar{x}$	13,153	8,556	14,820	7,467
s	3,255	4,712	970	4,046
c	24.7	55.1	6.5	54.2
				31.6
7-m depth				
1	8,880	d	10,800	11,700
2	12,400		11,800	9,280
3	10,240		8,320	14,100
$\bar{x}$	10,507		10,307	11,693
s	1,775		1,792	2,410
c	16.9		12.4	20.6
				18.2
				8,500
				6,500
				9,400
				8,133
				1,484
				18.2

TABLE C.5 (continued)

Watermass sampled ^a	Upstream			Near intake				
	Channel		Overbank	Channel		Dredged channel		Intake forebay
	Point 1 ^b	Point 2	Point 1 ^b	Point 2 ^c	Point 1 ^b	Point 2		
Watermass 3 (before sunrise)								
1-m depth								
1	11,600		27,993	11,800	22,244		7,500	
2	7,440		30,400	13,400	16,783		15,400	
3	18,600		18,560	8,240	20,400		13,073	
$\bar{x}$	12,547		25,651	11,147	19,809		11,991	
s	5,640		6,258	2,641	2,778		4,060	
c	45.0		24.4	23.7	14.0		33.9	
4-m depth								
1	14,000		27,726	9,600	18,200		20,000	
2	13,520		15,680	10,800	11,000		15,341	
3	16,700		11,072	12,500	10,880		22,400	
$\bar{x}$	14,740		18,159	10,967	13,360		19,277	
s	1,714		8,600	1,457	4,192		3,540	
c	11.6		47.4	19.8	31.4		18.4	
7-m depth								
1	13,900		d	9,280	15,984		8,700	
2	10,080			10,320	13,600		15,600	
3	21,211			15,100	12,500		12,000	
$\bar{x}$	15,064			11,567	14,028		12,100	
s	5,656			3,104	1,781		3,451	
c	37.5			26.8	12.7		28.5	

TABLE C.5 (continued)

Watermass sampled ^a	Upstream			Near intake		
	Channel Point 1 ^b	Point 2	Overbank Point 1 ^b	Channel Point 1 ^b	Dredged channel Point 1 ^b	Intake Point 2 forebay
Watermass 4 (after sunrise)						
1-m depth						
1	11,680		16,300	13,200	20,143	16,542
2	7,760		6,960	15,741	9,680	20,200
3	1,360		20,300	11,440	13,200	16,500
-x	6,933		14,520	13,460	14,341	17,747
s	5,209		6,846	2,162	5,324	2,124
c	73.1		47.2	16.1	37.1	12.0
4-m depth						
1	4,240		12,800	14,480	10,960	2,700
2	8,400		32,950	11,520	8,400	21,344
3	6,640		26,400	16,500	9,120	19,076
-x	6,427		24,050	14,167	9,493	14,373
s	2,088		10,279	2,505	1,320	10,173
c	32.5		42.7	17.7	13.9	70.8
7-m depth						
1	15,500	d		9,440	700	22,278
2	2,480			6,880	260	9,760
3	340			13,400	19,500	19,076
-x	6,107			9,907	6,822	17,038
s	8,205			3,285	10,987	6,503
c	134.3			33.2	1.6	38.2

TABLE C.5 (continued)

Watermass sampled ^a	Upstream			Near intake		
	Channel		Overbank	Channel		Intake forebay
	Point 1 ^b	Point 2		Point 1 ^b	Point 2	
Watermass 5 (noon)						
1-m depth						
1	1,200		12,000	13,400	9,600	11,800
2	340		26,013	7,871	6,420	11,700
3	360		28,014	10,960	16,600	10,900
-x	633		22,009	10,744	10,873	11,467
s	491		8,726	2,771	5,208	493
c	77.6		39.7	25.8	47.9	4.3
4-m depth						
1	5,440		18,142	10,720	8,000	8,938
2	600		4,400	6,960	13,840	8,240
3	6,720		2,720	5,920	5,360	10,138
-x	4,253		8,421	7,867	9,067	9,105
s	3,228		8,461	2,525	4,340	960
c	75.9		1.0	32.1	47.9	10.5
7-m depth						
1	3,920		d	10,080	7,680	11,606
2	6,160			4,880	23,800	8,404
3	7,360			3,120	17,300	10,805
-x	5,813			6,027	16,260	10,272
s	1,746			3,619	8,110	1,666
c	30.0			60.0	49.9	16.2

TABLE C.5 (continued)

Watermass sampled ^a	Upstream			Near intake		
	Channel		Overbank	Channel		Intake forebay
	Point 1 ^b	Point 2		Point 1 ^b	Point 2	
Watermass 6 (before sunset)						
1-m depth						
1	1,600		1,300		1,840	3,920
2	1,040		400		3,920	5,469
3	2,400		1,000		5,680	2,560
$\bar{x}$	1,680		900		3,813	3,983
s	684		458		1,922	1,456
c	40.7		50.9		50.4	36.5
4-m depth						
1	2,960		700		11,800	4,880
2	1,360		2,480		7,680	11,350
3	4,160		3,680		9,120	11,472
$\bar{x}$	2,827		2,287		9,533	9,237
s	1,405		1,499		2,091	3,774
c	49.7		65.6		21.9	40.9
7-m depth						
1	1,840		d		6,960	6,080
2	e				4,800	6,000
3	5,520				10,166	6,160
$\bar{x}$	3,680				7,309	6,080
s	2,602				2,700	80
c	70.7				36.9	1.3
						21.1

^aNumbers (1,2,3) indicate replicate number; $\bar{x}$ = mean; s = standard deviation; and c = coefficient of variation ($c = s/\bar{x} \times 100$).

^bNo samples collected from Point 1 in diel study.

^cAll 4 m recorded as 3 m.

^dNo samples collected from 7-m depth.

^eBottle empty.

TABLE C.6. DATA (no./m³) FOR SAMPLE SETS COLLECTED JULY 20-21, 1977 (DIEL STUDY),
FROM BROWNS FERRY NUCLEAR PLANT INTAKE AREA--CALANOIDA

Watermass sampled ^a	Upstream			Near intake		
	Channel		Overbank	Channel		Dredged channel
	Point 1 ^b	Point 2		Point 1 ^b	Point 2	
<u>July 20, 1977</u>						
Watermass 1 (after sunset)						
1-m depth						
1		933	533			
2		1,734	1,334		1,500	2,002
3		1,280	1,867		2,664	3,800
x					4,000	2,401
s		1,316	1,245		2,721	2,734
c		402	671		1,251	944
		30.5	54.0		46.0	34.5
						4,800
						3,000
						5,200
						4,333
						1,172
						27.0
4-m depth						
1		5,069	1,467		3,200	4,799
2		2,500	2,535		3,869	3,200
3		3,100	1,467		4,000	4,532
x						
s		3,556	1,823		3,690	4,177
c		1,344	617		429	857
		37.8	33.8		11.6	20.5
						63.8
7-m depth						
1			c			
2		3,300			3,869	5,066
3		2,500			3,469	3,600
x		4,402			2,400	2,000
s		3,401			3,246	3,555
c		955			759	1,533
		28.1			23.4	43.1
						33.5
						1,600
						800
						1,500
						1,300
						436
						33.5

TABLE C.6 (continued)

Watermass sampled ^a	Upstream			Near intake		
	Channel		Overbank	Channel		Dredged channel
	Point 1 ^b	Point 2	Point 1 ^b	Point 1 ^b	Point 2	Point 1 ^b
July 21, 1977						
Watermass 2 (midnight)						
1-m depth						
1	880		2,400	1,600		4,000
2	1,040		1,520	2,240		3,600
3	2,880		2,320	4,400		2,100
x	1,600		2,080	2,747		4,000
s	1,111		487	1,467		400
c	69.5		23.4	53.4		10.0
4-m depth						
1	1,520		1,520	3,500		3,400
2	1,600		2,268	3,360		4,300
3	2,100		3,335	3,200		5,200
x	1,740		2,374	3,353		4,300
s	314		912	150		900
c	18.1		38.4	4.5		20.9
7-m depth						
1	1,360		c	2,480		2,520
2	2,880			2,800		4,800
3	2,720			3,040		4,500
x	2,320			2,773		3,940
s	835			281		1,239
c	36.0			10.1		31.4
						40.8
						2,600
						1,400
						3,400
						2,467
						1,007
						40.8

TABLE C.6 (continued)

Watermass sampled ^a	Upstream			Near intake		
	Channel		Overbank	Channel		Intake forebay
	Point 1 ^b	Point 2		Point 1 ^b	Point 2	
Watermass 3 (before sunrise)						
1-m depth						
1	2,480		4,799	3,600	21,046	5,700
2	3,040		5,600	4,900	4,262	8,600
3	8,700		3,040	5,040	3,300	5,736
-x	4,740		4,480	4,513	9,535	6,679
s	3,441		1,310	794	9,980	1,664
c	72.6		29.2	17.6	104.7	24.9
4-m depth						
1	4,000		4,265	3,760	3,300	4,400
2	2,640		3,840	4,400	3,200	4,269
3	3,700		2,668	5,500	5,120	5,200
-x	3,447		3,591	4,553	3,873	4,956
s	715		827	880	1,681	1,079
c	20.7		23.0	19.3	27.9	21.8
7-m depth						
1	2,900		c	3,840	5,328	1,800
2	2,030			4,160	3,600	3,400
3	4,001			3,000	4,700	5,600
-x	2,294			3,667	4,543	3,600
s	964			599	875	1,908
c	32.2			16.3	19.3	53.0

TABLE C.6 (continued)

Watermass sampled ^a	Upstream			Near intake		
	Channel		Overbank	Channel		Intake forebay
	Point 1 ^b	Point 2		Point 1 ^b	Point 2	
Watermass 4 (after sunrise)						
1-m depth						
1	1,280		2,300	1,360	2,263	4,669
2	240		480	1,200	800	1,600
3	1,040		900	240	960	1,800
x	853		1,227	933	1,343	2,690
s	545		453	606	805	1,717
c	63.8		77.7	64.9	60.0	63.8
4-m depth						
1	880		1,680	1,520	480	3,400
2	400		3,068	560	400	2,801
3	1,840		1,400	1,500	720	1,734
x	1,040		2,049	1,193	533	2,645
s	733		893	549	167	844
c	70.5		43.6	46.0	31.2	31.9
7-m depth						
1	1,800		c	1,120	300	2,535
2	1,120			2,000	40	800
3	240			1,600	1,400	2,668
x	1,053			1,573	580	2,001
s	782			441	722	1,042
c	74.3			28.0	124.5	52.1

TABLE C.6 (continued)

Watermass sampled ^a	Upstream			Near intake		
	Channel		Overbank	Channel		Intake forebay
	Point 1 ^b	Point 2		Point 1 ^b	Point 2	
Watermass 5 (noon)						
1-m depth						
1	160	300		1,100	560	1,500
2	60	1,467		133	320	1,200
3	0	400		160	900	1,400
-x	110	722		464	593	1,367
s	71	647		551	291	153
c	64.3	89.6		118.6	49.1	11.2
4-m depth						
1	320	2,934		1,360	1,360	1,734
2	1,040	240		720	2,080	1,440
3	720	1,280		240	720	2,535
-x	693	1,485		773	1,387	1,903
s	361	1,359		562	680	567
c	52.0	91.5		72.7	49.1	29.8
7-m depth						
1	720	c		1,440	400	2,134
2	1,760			240	1,100	1,067
3	480			720	1,300	2,401
-x	987			800	933	1,867
s	680			604	473	706
c	70.0			75.5	50.6	37.8

TABLE C.6 (continued)

Watermass sampled ^a	Upstream			Near intake		
	Channel		Overbank	Channel		Dredged channel
	Point 1 ^b	Point 2		Point 1 ^b	Point 2	
Watermass 6 (before sunset)						
1-m depth						
1	720	300		720		560
2	320	1,500		400		1,868
3	640	1,200		560		2,200
$\bar{x}$	560	1,000		560		996
s	212	624		160		755
c	37.8	62.5		28.6		75.8
4-m depth						
1	640	800		1,700		320
2	800	1,100		1,120		640
3	160	500		400		1,201
$\bar{x}$	533	800		1,073		720
s	333	300		651		446
c	62.5	37.5		60.7		61.9
7-m depth						
1	320	c		800		560
2	d			1,200		640
3	1,600			720		720
$\bar{x}$	960			907		640
s	905			257		80
c	94.3			28.4		12.5
						20.4

^aNumbers (1,2,3) indicate replicate number; $\bar{x}$ = mean; s = standard deviation; and c = coefficient of variation ($c = s/\bar{x} \times 100$).

^bNo samples collected from Point 1 in diel study.

^cNo samples collected from 7-m depth.

^dNo sample collected.

TABLE C.7. DATA (no./m³) FOR SAMPLE SETS COLLECTED JULY 20-21, 1977 (DIEL STUDY),
FROM BROWNS FERRY NUCLEAR PLANT INTAKE AREA--*Diaptomus pallidus*

Watermass sampled ^a	Upstream			Near intake		
	Channel		Overbank	Channel		Dredged channel
	Point 1 ^b	Point 2	Point 1 ^b Point 2 ^c	Point 1 ^b	Point 2	Point 1 ^b Point 2
Intake forebay						
July 20, 1977						
Watermass 1 (after sunset)						
1-m depth						
1	0		133		200	534
2	0		400		799	1,400
3	0		667		1,000	1,601
x	0		400		666	1,178
s	0		267		416	567
c	0		66.8		62.5	48.1
4-m depth						
1	0		133		200	1,333
2	300		0		267	1,200
3	400		0		600	1,600
x	233		44		176	1,378
s	208		77		106	204
c	89.3		175.0		60.2	14.8
7-m depth						
1	100		d		400	533
2	0				267	1,200
3	0				160	400
x	33				276	711
s	58				120	429
c	175.8				43.5	60.3
						53.0

TABLE C.7 (continued)

Watermass sampled ^a	Upstream			Near intake		
	Channel		Overbank	Channel		Intake forebay
	Point 1 ^b	Point 2	Point 1 ^b	Point 2	Point 1 ^b	
July 21, 1977						
Watermass 2 (midnight)						
1-m depth						
1		80		320	600	1,200
2		80		560	400	1,840
3		1,200		640	600	1,200
-x		453		507	533	1,413
s		647		167	116	370
c		142.8		32.9	21.8	26.2
						534
						1,000
						700
						0
						300
						361
						120.3
4-m depth						
1		400		720	500	1,100
2		200		667	480	1,200
3		300		1,334	400	1,200
-x		300		907	460	1,167
s		100		371	53	58
c		33.3		40.9	11.5	5.0
7-m depth						
1		80		d	240	320
2		480			0	1,200
3		880			480	500
-x		480			240	673
s		400			240	465
c		83.3			100	69.1
						300
						436
						145.3

TABLE C.7 (continued)

Watermass sampled ^a	Upstream			Near intake		
	Channel		Overbank	Channel		Intake forebay
	Point 1 ^b	Point 2		Point 1 ^b	Point 2	
Watermass 3 (before sunrise)						
1-m depth						
1	1,360		533	1,200	2,531	1,100
2	800		0	2,100	1,865	2,000
3	4,800		320	3,040	900	2,001
-x	2,320		284	2,113	1,765	1,700
s	2,166		268	920	820	520
c	93.4		94.4	43.5	56.5	30.6
4-m depth						
1	1,360		0	2,080	1,100	400
2	560		160	2,560	1,000	1,601
3	600		0	2,500	2,880	1,800
-x	840		53	2,380	1,660	1,267
s	451		92	262	1,058	758
c	53.7		173.6	11.0	63.7	59.8
7-m depth						
1	600		d	1,680	2,131	200
2	480			1,360	1,100	1,200
3	800			700	1,500	1,600
-x	627			1,247	1,577	1,000
s	162			500	520	721
c	25.8			40.1	33.0	72.1

TABLE C.7 (continued)

Watermass sampled ^a	Upstream			Near intake		
	Channel Point 1 ^b	Point 2	Overbank Point 1 ^b Point 2 ^c	Channel Point 1 ^b Point 2	Dredged channel Point 1 ^b Point 2	Intake forebay
Watermass 4 (after sunrise)						
1-m depth						
1		80	400	0	400	934
2		0	80	133	80	400
3		0	0	0	80	400
x		27	160	44	187	578
s		46	212	77	185	308
c		170.4	132.5	175.0	98.9	53.3
4-m depth						
1		80	400	0	160	600
2		80	667	0	80	400
3		240	500	0	0	400
x		133	522	0	80	467
s		92	135	0	80	116
c		69.2	25.9	0	100	24.8
7-m depth						
1		0	d	0	60	267
2		80		80	0	160
3		60		0	100	800
x		47		27	53	409
s		42		46	50	343
c		88.6		170.4	94.3	83.9

TABLE C.7 (continued)

Watermass sampled ^a	Upstream			Near intake		
	Channel Point 1 ^b	Point 2	Overbank Point 1 ^b Point 2 ^c	Channel Point 1 ^b Point 2	Dredged channel Point 1 ^b Point 2	Intake forebay
Watermass 5 (noon)						
1-m depth						
1		0	100	0	80	200
2		0	0	0	80	0
3		0	0	0	100	0
x		0	33	0	87	67
s		0	58	0	12	116
c		0	175.8	0	13.8	173.1
4-m depth						
1		0	133	0	80 ^e	0
2		0	0	80	0	160
3		0	160	0	80	133
x		0	98	27	53	98
s		0	86	46	46	86
c		0	87.8	170.4	86.8	87.8
7-m depth						
1		0	d	0	0	133
2		160		80	0	0
3		0		0	300	0
x		53		27	100	44
s		92		46	173	77
c		173.6		170.4	173	175.0

TABLE C.7 (continued)

Watermass sampled ^a	Upstream			Near intake		
	Channel		Overbank	Channel		Intake forebay
	Point 1 ^b	Point 2		Point 1 ^b	Point 2	
Watermass 6 (before sunrise)						
1-m depth						
1	0	0	0	0	160	460
2	0	0	0	0	133	0
3	0	0	0	0	0	200
$\bar{x}$	0	0	0	0	98	220
s	0	0	0	0	86	231
c	0	0	0	0	87.8	105.0
4-m depth						
1	0	0	0	0	160	133
2	0	0	0	0	0	798
3	0	0	0	0	0	266
$\bar{x}$	0	0	0	0	53	399
s	0	0	0	0	92	352
c	0	0	0	0	173.6	88.2
7-m depth						
1	0	0	d	80	0	266
2	f	80		80	0	266
3	40	57		0	80	0
$\bar{x}$	142.5			53	27	177
s				46	46	154
c				86.8	58.7	87.0

^a Numbers (1,2,3) indicate replicate number; $\bar{x}$ = mean; s = standard deviation; and c = coefficient of variation ($c = s/\bar{x} \times 100$).

^b No samples collected from Point 1 in diel study.

^c All 4 m recorded as 3 m.

^d No samples collected from 7-m depth.

^e Recorded as 3 m.

^f No sample collected.

TABLE C.8. DATA (no./m³) FOR SAMPLE SETS COLLECTED JULY 20-21, 1977 (DIEL STUDY),
FROM BROWNS FERRY NUCLEAR PLANT INTAKE AREA--CYCLOPOIDA

Watermass sampled ^a	Upstream		Overbank	Near intake	
	Channel			Dredged channel	
	Point 1 ^b	Point 2		Point 1 ^b	Point 2
July 20, 1977					
Watermass 1 (after sunset)					
1-m depth					
1	3,735	2,267	3,900	1,867	8,400
2	4,401	1,468	4,396	4,200	4,200
3	3,040	1,601	6,000	2,801	7,200
-x	3,725	1,779	4,765	2,956	6,600
s	681	428	1,098	1,174	2,163
c	18.3	24.0	23.0	40.0	32.8
4-m depth					
1	4,801	2,802	5,400	6,665	3,600
2	3,000	5,602	5,069	7,200	4,400
3	3,900	3,068	4,400	6,665	3,600
-x	3,900	3,824	4,956	6,843	3,867
s	901	1,545	509	309	462
c	23.1	40.0	10.3	5.0	11.9
7-m depth					
1	3,900	c	4,135	5,598	5,200
2	5,200		3,735	3,600	3,600
3	6,537		2,800	3,400	4,500
-x	5,212		3,557	4,199	4,433
s	1,319		685	1,215	802
c	25.3		19.3	29.0	18.1

TABLE C.8 (continued)

Watermass sampled ^a	Upstream		Near intake	
	Channel		Dredged channel	
	Point 1 ^b	Point 2	Point 1 ^b	Point 2
July 21, 1977				
Watermass 2 (midnight)				
1-m depth				
1	1,120	2,640	1,800	3,600
2	400	2,320	3,120	2,400
3	1,440	4,160	7,200	2,200
$\bar{x}$	987	3,040	4,040	2,733
s	533	983	2,815	757
c	54.0	32.0	69.7	27.7
				41.6
4-m depth				
1	2,160	2,000	5,500	1,700
2	2,300	2,000	5,920	2,800
3	3,700	2,134	6,100	3,600
$\bar{x}$	2,720	2,045	5,840	2,700
s	852	77	308	954
c	31.3	4.0	5.3	35.3
				22.5
7-m depth				
1	2,000	c	5,440	3,100
2	3,680		4,800	3,200
3	2,720		4,012	5,500
$\bar{x}$	2,800		4,751	3,933
s	843		715	1,358
c	30.1		15.1	34.5
				24.0

TABLE C.8 (continued)

Watermass sampled ^a	Upstream			Near intake		
	Channel		Overbank	Channel		Intake forebay
	Point 1 ^b	Point 2		Point 1 ^b	Point 2	
Watermass 3 (before sunrise)						
1-m depth						
1	4,560	3,998		6,300	6,925	5,200
2	1,840	8,800		6,400	5,194	10,400
3	5,600	4,640		4,800	4,400	5,202
-x	4,000	5,813		5,833	5,506	6,934
s	1,942	2,607		896	1,291	3,002
c	48.5	45.0		15.4	23.4	43.3
4-m depth						
1	5,040	5,599		4,800	3,700	6,400
2	4,320	4,800		6,160	4,400	4,002
3	6,000	3,201		5,100	3,600	5,000
-x	5,120	4,533		5,353	3,900	5,134
s	843	1,221		715	436	1,205
c	16.5	27.0		13.3	11.2	23.5
7-m depth						
1	4,400	c		4,560	4,396	2,300
2	3,600			5,520	4,200	6,600
3	5,470			4,800	4,500	7,600
-x	4,490			4,960	4,365	5,500
s	938			500	152	2,816
c	20.9			10.1	3.5	51.2

TABLE C.8 (continued)

Watermass sampled ^a	Upstream		Near intake	
	Channel Point 1 ^b	Overbank Point 2	Channel Point 1 ^b	Dredged channel Point 2
Watermass 4 (after sunrise)				
1-m depth				
1	1,680	1,900	2,480	2,668
2	960	960	2,801	1,040
3	1,120	1,500	960	1,920
x	1,253	1,453	2,080	1,876
s	378	472	983	815
c	30.2	33.0	47.3	43.4
4-m depth				
1	1,600	1,200	1,920	880
2	1,680	6,002	1,440	560
3	2,960	3,000	1,800	1,120
x	2,080	3,401	1,720	853
s	765	2,426	250	281
c	36.7	71.3	14.5	32.9
7-m depth				
1	3,100	c	2,160	380
2	1,600		1,280	20
3	200		2,200	2,900
x	1,633		1,880	1,100
s	1,450		520	1,569
c	88.8		27.7	142.7
				60.2

TABLE C.3 (continued)

Watermass sampled ^a	Upstream			Near intake		
	Channel		Overbank	Channel		Intake forebay
	Point 1 ^b	Point 2		Point 1 ^b	Point 2	
Watermass 5 (noon)						
1-m depth						
1		240	500		3,000	1,200
2		860	800		1,600	1,120
3		480	267		1,040	1,500
x		527	522		1,880	1,273
s		313	267		1,010	200
c		59.4	51.2		53.7	15.7
4-m depth						
1		2,000	1,733		3,920	720
2		4,240	560		2,480	640
3		3,680	560		1,040	640
x		3,307	951		2,480	667
s		1,166	677		1,440	46
c		35.3	71.2		58.1	6.9
7-m depth						
1		1,200	c		2,400	1,200
2		1,920			2,560	4,500
3		1,360			1,440	3,500
x		1,493			2,133	3,067
s		378			606	1,692
c		25.3			28.4	55.2
						37.6

TABLE C.8 (continued)

Watermass sampled ^a	Upstream			Near intake		
	Channel		Overbank	Dredged channel		Intake
	Point 1 ^b	Point 2	Point 1 ^b	Point 1 ^b	Point 2	forebay
Watermass 6 (before sunset)						
1-m depth						
1	1,200		1,000		2,160	2,268
2	1,280		1,000		2,535	2,600
3	2,400		900		1,280	4,200
$\bar{x}$	1,627		967		1,992	3,023
s	671		55		644	1,033
c	41.3		6.0		32.3	34.2
4-m depth						
1	2,880		800		1,520	2,668
2	2,000		1,000		2,000	2,926
3	2,240		1,300		3,068	1,330
$\bar{x}$	2,373		1,033		2,196	2,308
s	455		252		792	857
c	19.2		24.4		36.1	37.1
7-m depth						
1	2,880		c		2,080	3,990
2	d				1,680	2,394
3	1,360				1,920	3,990
$\bar{x}$	2,120				1,893	3,458
s	1,075				201	921
c	50.7				10.6	26.6

^aNumbers (1,2,3) indicate replicate number; $\bar{x}$ = mean; s = standard deviation; and c = coefficient of variation ($c = s/\bar{x} \times 100$).

^bNo samples collected from Point 1 in diel study.

^cNo samples collected from 7-m depth.

^dNo sample collected.

TABLE C.9. DATA (no./m³) FOR SAMPLE SETS COLLECTED JULY 20-21, 1977 (DIEL STUDY),
FROM BROWNS FERRY NUCLEAR PLANT INTAKE AREA--Mesocyclops edax

Watermass sampled ^a	Upstream			Near intake		
	Channel		Overbank	Channel		Dredged channel
	Point 1 ^b	Point 2	Point 1 ^b Point 2 ^c	Point 1 ^b	Point 1 ^b Point 2	Point 1 ^b Point 2 Intake forebay
July 20, 1977						
Watermass 1 (after sunset)						
1-m depth						
1	2,001		667	2,200	667	3,600
2	1,868		534	2,398	2,200	1,800
3	1,600		267	2,600	1,067	3,600
-x	1,823		489	2,399	1,311	3,000
s	204		204	200	795	1,039
c	11.2		41.7	8.3	60.6	34.6
4-m depth						
1	2,401		1,201	2,600	2,399	2,400
2	1,800		2,001	1,734	1,200	2,400
3	1,700		800	1,700	2,666	1,200
-x	1,967		1,334	2,011	2,088	2,000
s	379		612	510	781	693
c	19.3		45.9	25.4	37.4	34.7
7-m depth						
1	1,900		d	1,467	1,866	2,400
2	1,700			1,334	1,200	1,200
3	2,668			1,280	800	1,500
-x	2,020			1,360	1,289	1,700
s	350			96	599	625
c	17.3			7.1	41.8	36.8

TABLE C.9 (continued)

Watermass sampled ^a	Upstream		Near intake		
	Channel Point 1 ^b	Overbank Point 2 Point 1 ^b Point 2 ^c	Channel Point 1 ^b Point 2	Dredged channel Point 1 ^b Point 2	Intake forebay
July 21, 1977					
Watermass 2 (midnight)					
1-m depth					
1	400	960	500	1,100	534
2	80	1,040	1,040	1,120	2,200
3	400	2,080	4,200	900	1,000
-x	293	1,360	1,913	1,040	1,245
s	185	625	1,999	122	860
c	63.1	46.0	104.5	11.7	69.1
4-m depth					
1	1,120	880	2,900	700	1,400
2	1,400	400	2,080	1,200	700
3	1,600	800	3,300	1,200	800
-x	1,373	693	2,760	1,033	967
s	241	257	622	289	379
c	17.6	37.1	22.5	28.0	39.2
7-m depth					
1	960	d	2,140	1,000	1,200
2	1,440		2,000	1,520	1,200
3	1,120		2,000	2,900	1,400
-x	1,173		2,047	1,807	1,267
s	244		81	982	116
c	20.8		4.0	54.3	9.2

TABLE C.9 (continued)

Watermass sampled ^a	Upstream			Near intake		
	Channel		Overbank	Channel		Intake forebay
	Point 1 ^b	Point 2		Point 1 ^b	Point 2	
Watermass 3 (before sunrise)						
1-m depth						
1	3,360		1,866	4,400	4,262	3,200
2	1,520		4,000	3,800	3,330	6,400
3	2,900		1,920	3,520	2,300	3,335
-x	2,593		2,595	3,907	3,297	4,312
s	958		1,217	450	981	1,810
c	36.9		46.9	11.5	29.8	42.0
4-m depth						
1	2,880		3,199	3,680	1,900	3,200
2	2,720		1,760	4,080	3,200	2,801
3	3,700		1,467	3,200	1,680	3,200
-x	3,100		2,142	3,653	2,260	3,067
s	526		927	441	827	230
c	17.0		43.3	12.1	36.6	7.5
7-m depth						
1	2,800		d	2,800	3,064	1,400
2	2,480			3,280	3,400	3,600
3	3,202			3,200	3,200	4,200
-x	2,827			3,093	3,221	3,067
s	362			257	169	1,474
c	12.8			8.3	5.2	48.1

TABLE C.9 (continued)

Watermass sampled ^a	Upstream			Near intake		
	Channel		Overbank	Channel		Intake forebay
	Point 1 ^b	Point 2		Point 1 ^b	Point 2	
Watermass 4 (after sunrise)						
1-m depth						
1	560	300		560	800	267
2	80	320		400	160	400
3	240	200		0	400	300
$\bar{x}$	293	273		320	453	322
s	244	64		298	323	69
c	83.3	23.4		90	71.3	21.4
4-m depth						
1	640	320		400	160	200
2	640	1,467		80	160	0
3	1,120	600		700	240	267
$\bar{x}$	800	796		393	187	156
s	277	598		310	46	139
c	34.6	75.1		78.9	24.6	89.1
7-m depth						
1	1,200	d		160	60	534
2	480			0	20	160
3	40			400	800	267
$\bar{x}$	573			187	293	320
s	586			201	439	193
c	102.3			107.5	149.8	60.0

TABLE C.9 (continued)

Watermass sampled ^a	Upstream			Near intake		
	Channel		Overbank	Channel		Intake
	Point 1 ^b	Point 2		Point 1 ^b	Point 2	
Watermass 5 (noon)						
1-m depth						
1		0			0	0
2		200			80	600
3		120			200	300
x		107			93	300
s		101			101	300
c		94.4			92.1	100
4-m depth						
1	640					
2	1,440		133	1,120	320 ^e	267
3	1,200		80	400	160	0
x			0	400	160	0
s	1,093		71	640	213	89
c	411		67	416	92	154
	37.6		94.4	65.0	43.2	173.0
7-m depth						
1	400		d			
2	560			400	240	133
3	320			800	2,000	0
x	427			480	1,500	0
s	122			560	1,247	44
c	28.6			212	907	77
				37.9	72.7	175.0

TABLE C.9 (continued)

Watermass sampled ^a	Upstream			Near intake		
	Channel		Overbank	Channel		Intake forebay
	Point 1 ^b	Point 2		Point 1 ^b	Point 2	
Watermass 6 (before sunset)						
1-m depth						
1	400		400	560	640	1,067
2	320		100	560	534	400
3	720		200	1,200	400	1,200
-x	480		233	773	525	889
s	212		153	370	120	429
c	44.2		65.7	47.9	22.9	48.3
4-m depth						
1	1,600		300	400	320	1,067
2	880		400	560	560	1,064
3	1,120		200	320	800	798
-x	1,200		300	427	560	976
s	367		100	86	240	155
c	30.6		33.3	20.1	42.9	15.9
7-m depth						
1	480		d	80	720	1,862
2	f			160	640	1,064
3	560			400	720	1,596
-x	520			213	693	1,507
s	57			167	46	406
c	11.0			78.4	6.6	26.9

^aNumbers (1,2,3) indicate replicate number; $\bar{x}$ = mean; s = standard deviation; and c = coefficient of variation ($c = s/\bar{x} \times 100$).

^bNo samples collected from Point 1 in diel study.

^cAll 4 m recorded as 3 m.

^dNo samples collected from 7-m depth.

^eRecorded as 3 m.

^fBottle empty.

TABLE C.10. DATA (no./m³) FOR SAMPLE SETS COLLECTED JULY 20-21, 1977 (DIEL STUDY),
FROM BROWNS FERRY NUCLEAR PLANT INTAKE AREA--NAUPLII

Watermass sampled ^a	Upstream			Near intake		
	Channel		Overbank	Channel		Intake forebay
	Point 1 ^b	Point 2		Point 1 ^b	Point 2	
July 20, 1977						
Watermass 1 (after sunset)						
1-m depth						
1	8,271		3,202			20,400
2	6,937		6,003		7,000	17,400
3	4,800		6,803		6,400	7,200
-x	6,669		5,336		6,775	15,000
s	1,751		1,891		327	6,920
c	26.3		35.4		4.8	46.1
4-m depth						
1	20,143		4,002		16,200	11,200
2	9,800		13,340		12,406	12,400
3	11,000		4,269		12,900	11,600
-x	13,648		7,204		13,835	11,733
s	5,657		5,316		2,063	611
c	41.5		73.8		14.9	5.2
7-m depth						
1	11,500		c		12,006	5,600
2	13,900				12,673	10,400
3	15,609				9,120	8,100
-x	13,670				11,266	8,033
s	2,064				1,888	2,401
c	15.1				16.8	29.9

TABLE C.10 (continued)

Watermass sampled ^a	Upstream			Near intake		
	Channel		Overbank	Channel		Intake forebay
	Point 1 ^b	Point 2	Point 1 ^b	Point 1 ^b	Point 2	
<u>July 21, 1977</u>						
Watermass 2 (midnight)						
1-m depth						
1	4,800		8,880		4,800	8,671
2	7,360		7,120		7,040	12,000
3	7,280		10,160		14,600	4,900
-x	6,480		8,720		8,813	8,524
s	1,455		1,526		5,135	3,552
c	22.5		17.5		58.3	41.7
4-m depth						
1	5,290		5,280		11,100	7,800
2	8,700		5,069		11,680	5,800
3	8,600		7,204		10,100	11,800
-x	7,740		5,838		10,960	8,467
s	1,577		1,190		799	3,055
c	20.3		20.4		7.3	36.1
7-m depth						
1	6,080		c		4,240	5,600
2	8,640				9,000	5,000
3	7,360				8,480	13,800
-x	7,360				7,240	8,133
s	1,280				2,611	4,917
c	17.4				36.1	60.5

TABLE C.10 (continued)

Watermass sampled ^a	Upstream			Near intake		
	Channel		Overbank	Channel		Intake forebay
	Point 1 ^b	Point 2		Point 1 ^b	Point 2	
Watermass 3 (before sunrise)						
1-m depth						
1	5,360	13,063		8,800	13,320	7,100
2	3,200	13,600		6,600	6,926	17,400
3	5,800	4,320		7,520	7,700	10,405
-x	4,787	10,327		7,640	9,315	11,635
s	1,392	5,210		1,105	3,490	5,259
c	29.1	50.4		14.5	37.5	45.2
4-m depth						
1	6,240	10,131		3,440	5,200	12,400
2	4,640	6,400		5,360	5,900	8,804
3	8,000	8,538		9,300	7,760	10,600
-x	6,293	8,356		6,033	6,287	10,601
s	1,681	1,872		2,987	1,323	1,798
c	26.7	22.4		49.5	21.0	17.0
7-m depth						
1	9,100	c		7,120	7,592	5,100
2	4,560			7,920	4,900	8,800
3	11,206			7,800	6,500	11,600
-x	8,289			7,613	6,331	8,500
s	3,396			431	1,354	3,260
c	41.0			5.7	21.4	38.4

TABLE C.10 (continued)

Watermass sampled ^a	Upstream			Near intake		
	Channel		Overbank	Dredged channel		Intake forebay
	Point 1 ^b	Point 2	Point 1 ^b	Point 2	Point 1 ^b	
Watermass 4 (after sunrise)						
1-m depth						
1	8,400		1,900	5,680	8,271	7,470
2	4,880		4,802	7,871	4,080	7,600
3	4,880		1,440	3,280	4,880	4,200
-x	6,053		2,714	5,610	5,744	6,423
s	2,032		1,823	2,296	2,225	1,927
c	33.6		67.2	40.9	38.7	30.0
4-m depth						
1	4,320		1,900	3,520	2,000	8,600
2	3,600		1,760	3,600	2,880	6,003
3	5,120		7,800	4,000	1,920	3,602
-x	4,347		3,820	3,707	2,267	6,068
s	760		3,447	257	533	2,500
c	17.5		90.3	6.9	23.5	41.2
7-m depth						
1	6,500		c	4,720	940	6,937
2	4,880			4,640	80	3,680
3	380			7,500	2,800	4,402
-x	3,920			5,620	1,273	5,006
s	3,171			1,629	1,390	1,711
c	80.9			29.0	109.2	34.2

TABLE C.10 (continued)

Watermass sampled ^a	Upstream			Near intake		
	Channel		Overbank	Channel		Dredged channel
	Point 1 ^b	Point 2		Point 1 ^b	Point 2	
Watermass 5 (noon)						
1-m depth						
1	1,520		3,200			3,920
2	740		4,269			3,440
3	600		2,535			5,000
$\bar{x}$	953		3,335			4,120
s	496		875			799
c	52.0		26.2			19.4
						41.1
4-m depth						
1	2,000		4,402			6,000
2	1,860		1,360			3,920
3	6,000		2,960			4,160
$\bar{x}$	3,287		2,907			4,693
s	2,350		1,522			1,138
c	71.5		52.3			24.3
						40.4
7-m depth						
1	3,120		c			2,160
2	3,200					2,500
3	5,440					3,500
$\bar{x}$	3,920					2,720
s	1,317					697
c	33.6					25.6
						667
						12.5
						6,003
						4,669
						5,336
						5,336
						667
						12.5

TABLE C.10 (continued)

Watermass sampled ^a	Upstream			Near Intake		
	Channel Point 1 ^b	Point 2	Overbank Point 1 ^b	Channel Point 1 ^b	Dredged channel Point 1 ^b	Intake Point 2 forebay
Watermass 6 (before sunset)						
1-m depth						
1	1,920		2,700	3,600	2,320	5,736
2	2,320		4,400	2,320	4,536	5,800
3	3,200		1,500	2,240	1,200	8,800
$\bar{x}$	2,480		2,867	2,720	2,685	6,779
s	655		1,457	763	1,698	1,751
c	26.4		50.8	28.1	63.2	25.8
4-m depth						
1	5,920		1,900	8,100	2,480	4,802
2	5,360		2,960	6,240	2,240	6,916
3	8,560		2,480	3,040	8,404	6,384
$\bar{x}$	6,613		2,447	5,793	4,375	6,034
s	1,709		531	2,559	3,492	1,100
c	25.8		21.7	44.2	79.8	18.2
7-m depth						
1	4,080		c	3,140	2,320	7,182
2	d			2,080	1,200	8,778
3	11,200			4,400	2,240	10,906
$\bar{x}$	7,640			3,307	1,920	8,955
s	5,035			1,166	625	1,868
c	65.9			35.3	32.5	20.9

^aNumbers (1,2,3) indicate replicate number; $\bar{x}$ = mean; s = standard deviation; and c = coefficient of variation ($c = s/\bar{x} \times 100$).

^bNo samples collected from Point 1 in diel study.

^cNo samples collected from 7-m depth.

^dNo sample collected.

APPENDIX D

DATA (no./m³) FOR SAMPLE SETS COLLECTED
SEPTEMBER 22 AND 23, 1976, FROM
GALLATIN STEAM PLANT INTAKE AREA

TABLE 2.1. DATA NO. 12.1 PER SAMPLE SETS COLLECTED SEPTEMBER 22, 1976, FROM BALLAST TANK PLANT INTAKE AREA

Taxonomic group ^a	Channel		Edge of channel		Front of skimmer		Back of skimmer-15 m		Back of skimmer-20 m	
	Point 1	Point 2	Point 1	Point 2	Point 1	Point 2	Point 1	Point 2	Point 1	Point 2
Total zooplankton										
1	407,060	377,775	417,810	430,707	731,210	379,381	126,377	114,348	135,746	145,047
2	397,430	123,150	353,430	410,369	589,138	477,152	175,509	85,610	131,553	148,132
3	401,287	265,277	385,629	420,538	660,269	428,267	150,243	100,004	135,650	146,693
4	9,230	99,950	45,923	14,381	100,424	69,134	34,741	20,356	5,793	2,327
5	2.1	22.4	11.8	3.4	15.2	16.1	23.0	20.4	4.3	1.6
Rotifera										
1	349,485	260,051	350,525	390,851	664,441	343,056	86,551	76,702	102,087	103,774
2	340,323	124,007	310,053	395,870	537,234	429,262	124,121	55,610	91,990	105,134
3	344,304	256,270	330,374	333,361	600,838	386,464	105,365	66,156	97,039	104,455
4	5,475	50,177	28,738	3,348	89,349	60,525	26,560	14,214	7,139	963
5	1.9	25.5	8.7	0.3	14.9	15.6	25.2	22.5	7.4	2.3
Synchaeta spp.										
1	118,446	70,442	63,490	96,320	179,883	111,860	16,277	13,874	17,922	19,576
2	101,613	249	51,852	100,176	162,089	150,703	28,830	12,927	13,350	28,097
3	110,030	35,346	97,671	98,548	170,996	131,282	20,554	13,401	15,636	23,837
4	11,903	49,634	8,229	2,302	12,625	27,466	6,048	670	3,233	6,025
5	10.6	140.4	14.3	2.3	7.4	20.9	29.4	5.0	20.7	25.3
Cladocera										
1	5,384	1,398	9,235	5,435	5,426	1,011	4,257	5,497	6,806	4,245
2	3,763	5,453	5,820	5,712	10,229	879	5,518	2,927	7,282	3,625
3	4,574	3,426	7,878	5,574	7,828	945	4,888	4,212	7,044	3,935
4	1,146	2,867	2,910	195	3,396	93	892	1,517	377	438
5	25.1	93.6	36.9	3.5	43.4	9.8	18.2	43.1	4.8	11.1
Diaphanosoma leuchtenbergianum										
1	4,214	293	7,270	2,264	4,174	674	751	1,309	2,722	1,551
2	2,419	4,362	2,116	2,197	6,956	879	2,547	1,951	3,155	2,115
3	3,317	2,308	4,693	2,231	5,565	777	1,649	1,630	2,939	1,883
4	1,269	2,877	3,644	47	1,967	145	1,270	454	366	388
5	36.3	123.6	77.7	2.1	35.3	18.7	77.0	27.9	10.4	17.4
Calanoida										
1	5,150	3,867	6,545	4,076	5,843	1,685	2,003	2,880	1,361	3,066
2	3,226	4,362	3,439	3,954	3,682	3,954	2,759	2,195	971	4,230
3	4,188	4,115	4,991	4,015	4,763	2,820	2,381	2,538	1,166	3,648
4	1,360	350	2,196	86	1,528	1,604	534	484	275	823
5	32.5	8.5	44.0	2.2	32.1	56.9	22.4	19.1	23.6	22.6

TABLE 2.1 (continued)

Taxonomic group ^a	Channel		Edge of channel		Front of skimmer		Back of skimmer--15 m		Back of skimmer--30 m	
	Point 1	Point 2	Point 1	Point 2	Point 1	Point 2	Point 1	Point 2	Point 1	Point 2
Calanoid										
(immature)										
1	4,214	3,591	4,847	3,623	5,043	1,348	2,003	2,880	1,361	2,332
2	2,419	4,362	3,175	3,076	3,682	3,954	2,759	1,951	971	4,230
x	3,317	3,977	4,011	3,350	4,763	2,651	2,381	2,416	1,166	3,530
s	1,263	545	1,182	387	1,528	1,533	535	657	276	330
c	38.3	13.7	29.5	11.5	32.1	69.5	22.5	27.2	23.7	38.0
Cyclopoid										
(immature)										
1	2,575	3,315	7,524	3,172	2,322	1,685	25,042	5,806	8,848	2,570
2	2,413	2,181	1,381	4,394	4,210	2,635	11,248	2,098	20,631	9,358
x	2,407	2,748	3,403	3,782	3,216	2,160	13,145	6,482	14,740	9,128
s	110	801	1,571	865	1,405	671	9,753	500	8,331	125
c	22.2	29.2	45.0	22.5	35.9	31.1	53.7	7.7	55.5	2.3
Cyclopoid										
(immature)										
1	2,575	3,039	4,120	2,717	2,504	574	5,259	6,021	5,672	8,431
2	2,419	2,181	2,381	3,515	3,682	1,757	7,640	5,610	7,282	7,355
x	2,407	2,510	3,251	3,116	3,093	1,215	6,450	5,816	6,477	5,173
s	110	507	1,230	562	833	766	1,684	291	1,139	50
c	4.7	23.2	37.8	18.1	26.9	63.0	26.1	5.0	17.6	5.5
Nauplii										
1	44,242	29,334	46,042	27,174	52,170	31,334	25,042	22,513	20,644	24,333
2	45,699	27,263	31,746	39,104	33,142	40,422	31,834	18,781	20,631	25,352
x	44,971	27,549	35,394	33,139	42,656	35,878	33,435	20,617	20,638	25,136
s	1,030	1,818	1,109	8,436	13,455	6,426	4,802	2,639	9	1,224
c	2.3	5.7	25.9	25.7	31.5	17.9	16.3	12.8	3.04	2.7

^aNumbers 1,2 indicate replicate number; $\bar{x}$ = mean; s = standard deviation; and c = coefficient of variation ($c = s/\bar{x} \times 100$).

TABLE D.2 (continued)

Taxonomic group ^a	Channel		Edge of channel		Front of skimmer		Back of skimmer--15 m		Back of skimmer--90 m	
	Point 1	Point 2	Point 1	Point 2	Point 1	Point 2	Point 1	Point 2	Point 1	Point 2
Calanoid										
(immature)										
1	2,926	1,394	2,570	2,125	3,316	3,565	1,675	1,695	1,592	1,296
2	4,478	2,520	1,839	954	4,199	2,069	1,684	1,917	1,623	1,216
$\bar{x}$	3,702	1,777	2,005	1,540	3,758	2,817	1,680	1,806	1,608	1,256
s	1,397	413	500	828	524	1,058	6	157	22	57
c	29.5	25.3	39.9	53.8	16.6	37.5	0.4	8.7	1.4	4.5
Cyclopoida										
1	4,475	1,394	1,169	2,922	5,041	2,036	13,756	11,228	14,013	8,334
2	1,493	1,010	517	573	3,554	1,724	5,992	9,145	14,783	9,727
$\bar{x}$	2,983	1,202	893	1,748	2,548	1,880	11,874	10,187	14,396	9,031
s	2,108	271	390	1,661	716	220	2,661	1,472	54	985
c	70.5	22.5	13.7	95.0	28.1	11.7	22.4	14.5	3.8	10.9
Cyclopoid										
(immature)										
1	4,475	1,394	935	2,125	2,041	1,876	8,612	8,686	6,847	5,741
2	1,493	1,010	411	573	2,863	1,724	5,838	7,375	8,113	5,927
$\bar{x}$	2,984	1,202	673	1,349	2,452	1,800	7,225	8,031	7,840	5,834
s	2,109	272	371	1,097	581	107	1,962	927	895	132
c	70.7	22.6	55.1	81.4	23.7	6.0	27.1	11.5	11.4	2.3
Neuplii										
1	19,277	23,593	23,131	20,452	25,765	24,578	16,059	22,670	15,605	14,630
2	23,454	13,313	22,615	14,122	23,092	18,966	12,463	15,487	20,553	18,693
$\bar{x}$	21,366	18,453	22,873	17,287	24,429	21,772	14,246	19,079	18,379	16,662
s	2,953	7,335	22,873	4,475	1,690	3,968	2,551	5,073	3,499	2,873
c	13.8	39.5	100	25.5	7.7	18.2	17.7	26.6	19.4	17.2

^aNumbers (1,2) indicate replicate number; $\bar{x}$ = mean; s = standard deviation; and c = coefficient of variation ($c = s/\bar{x} \times 100$).

APPENDIX E

THREE-DIMENSIONAL FLOW PATTERNS
NEAR THE SUBMERGED INTAKE OF THE
TVA GALLATIN STEAM PLANT

Tennessee Valley Authority
Division of Water Management
Water Systems Development Branch

THREE-DIMENSIONAL FLOW PATTERNS
NEAR THE SUBMERGED INTAKE OF THE
TVA GALLATIN STEAM PLANT

Report No. WM28-1-39-100

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October 1978

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ABSTRACT

A computer model has been developed describing the flow patterns in the vicinity of the intake for cooling water of the TVA Gallatin Steam Plant. These flow patterns were used to assist in the interpretation of results from zooplankton sampling near the water intake. Gallatin Steam Plant withdraws approximately $37 \text{ m}^3/\text{sec}$ ($1320 \text{ ft}^3/\text{sec}$) of water from the Cumberland River through an intake channel 840 meters (2750 feet) long. A skimmer wall designed to withdraw cool water from the lower layers of the river separates this intake channel from the river. The opening under the skimmer wall is 5.5 by 95 meters (18 by 310 feet), the top of which is approximately 9.5 meters (31 feet) below the water surface. River flows in the vicinity of the plant are usually unsteady because of the operation of upstream and downstream hydroelectric plants. A finite difference computer model was used to calculate the resulting three-dimensional flow patterns which occurred during a diel (24 hours) biological study. By determining these flow patterns in the vicinity of the skimmer wall, the source of the zooplankton drawn into the intake channel could be better defined. This report discusses the application of the three-dimensional hydrodynamic computer model and the resulting flow fields.

INTRODUCTION

A power generating plant uses water pumped from an adjacent river or a body of water in its condenser cooling water system. Planktonic organisms within this water are subjected to multiple stresses while passing through the condenser cooling system. These stresses can result in immediate and/or latent effects ranging from immediate death to loss in fecundity. Since planktonic organisms are vital to most aquatic ecosystems, it is important to understand how various intake designs affect the quantity of plankton entrained.

The plankton are unevenly distributed throughout a waterbody depending upon many physical factors such as light, temperature and water movement. An understanding of the flow patterns near the intake and the source of the water entrained into the plant can assist in the interpretation of biological sampling in the waterbody and within the intake region. To assist in studying these flow patterns, a hydrodynamic computer model was developed. This report presents the results of an analysis of the flow patterns in the vicinity of the intake of a TVA generating plant which was being investigated by TVA aquatic biologists for the purpose of evaluating the entrainment of zooplankton.

This work was conducted as part of the Federal Interagency Energy/Environment Research and Development Program with funds administered through the Environmental Protection Agency, TVA Contract No. TV-41968A, and suborder from the Division of Environmental Planning.

The EPA Project Officer for this research project is Dr. Clinton Hall, 401 M Street, S.W., Washington, D.C. 20460, and the TVA Project Director is Billy G. Isom, E&D Building, Muscle Shoals, Alabama 35660. The principal investigator for the project is Don Dycus. His contributions to the direction of the research and constructive review of the reported results are gratefully acknowledged.

SITE OF THE INVESTIGATION

This investigation addresses flows near the intake of the TVA Gallatin Steam Plant. This plant is situated in north central Tennessee on the north shore of Old Hickory Reservoir of the Cumberland River (Figure 1). River flows in the vicinity of the plant are often unsteady because of the operation of the hydroelectric plants downstream at Old Hickory Dam and upstream at Cordell Hull and Center Hill Dams. The actual releases from these dams were used in a one-dimensional flow routing model to compute the flows at the plant site during the diel biological sampling period. This computation, shown in Figure 2, revealed that the flows varied between a low of $17 \text{ m}^3/\text{sec}$ ($600 \text{ ft}^3/\text{sec}$) and a high of $540 \text{ m}^3/\text{sec}$ ($19,000 \text{ ft}^3/\text{sec}$).

The Gallatin Steam Plant uses the open cycle technique for condenser cooling. Approximately $37 \text{ m}^3/\text{sec}$ ($1320 \text{ ft}^3/\text{sec}$) of condenser cooling water is withdrawn from the Cumberland River through an intake channel which is 840 m (2750 ft) long. As shown in Figure 3, the intake channel is separated from the river by a skimmer wall which extends approximately 9.5 m (31 ft) below the water surface when the reservoir is at normal summer levels. The opening under the skimmer wall is approximately 5.5 m (18 ft) high and 95 m (310 ft) wide. The skimmer wall was designed to withdraw cooler water from the lower strata of the reservoir, but during the testing period in September 1977, temperature differences throughout this reach of the river were assumed to be negligible.

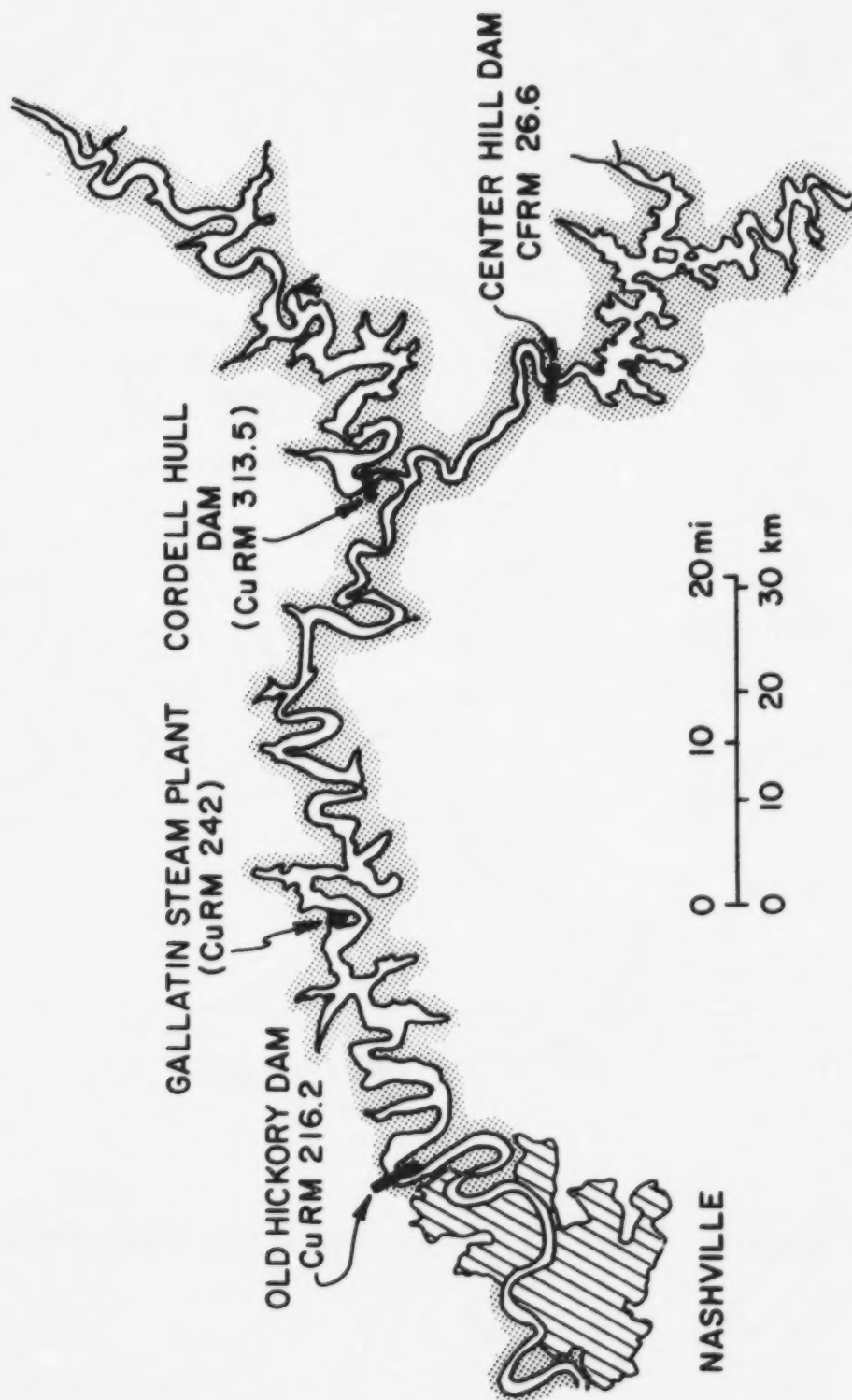


Figure 1: Location Map of Gallatin Steam Plant

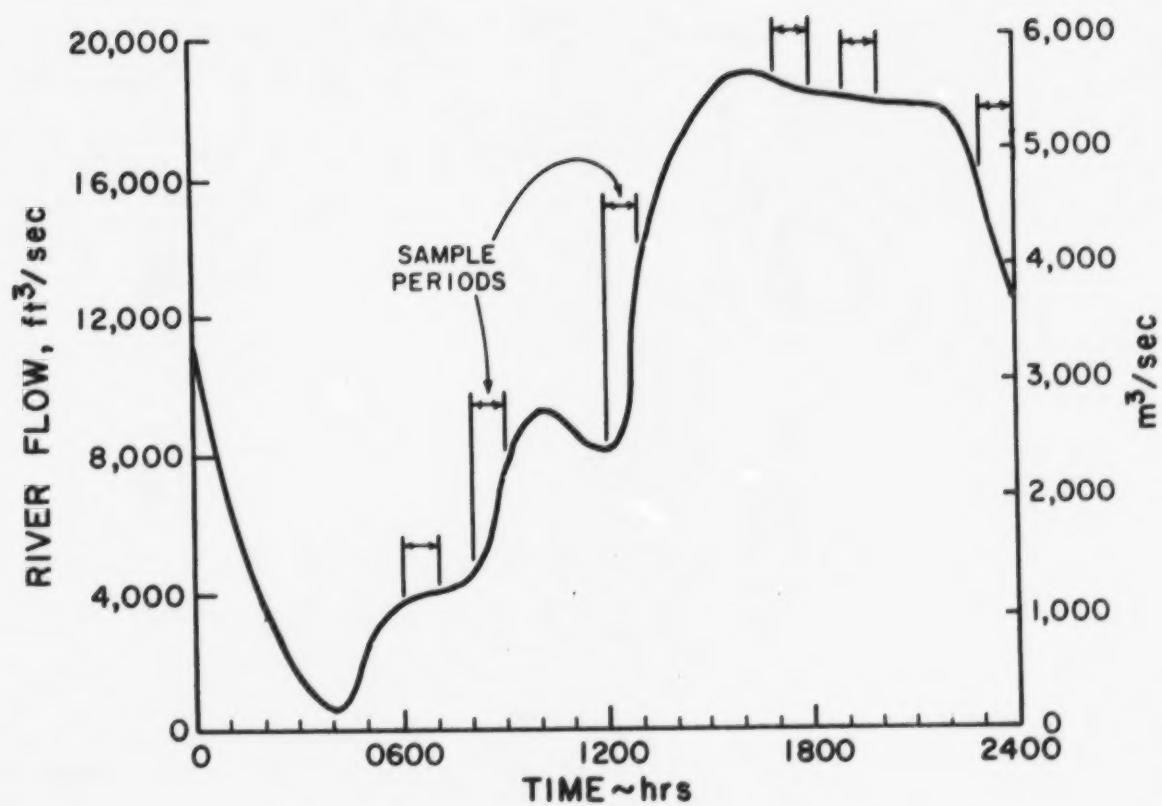


Figure 2: River Flows During Sampling Period

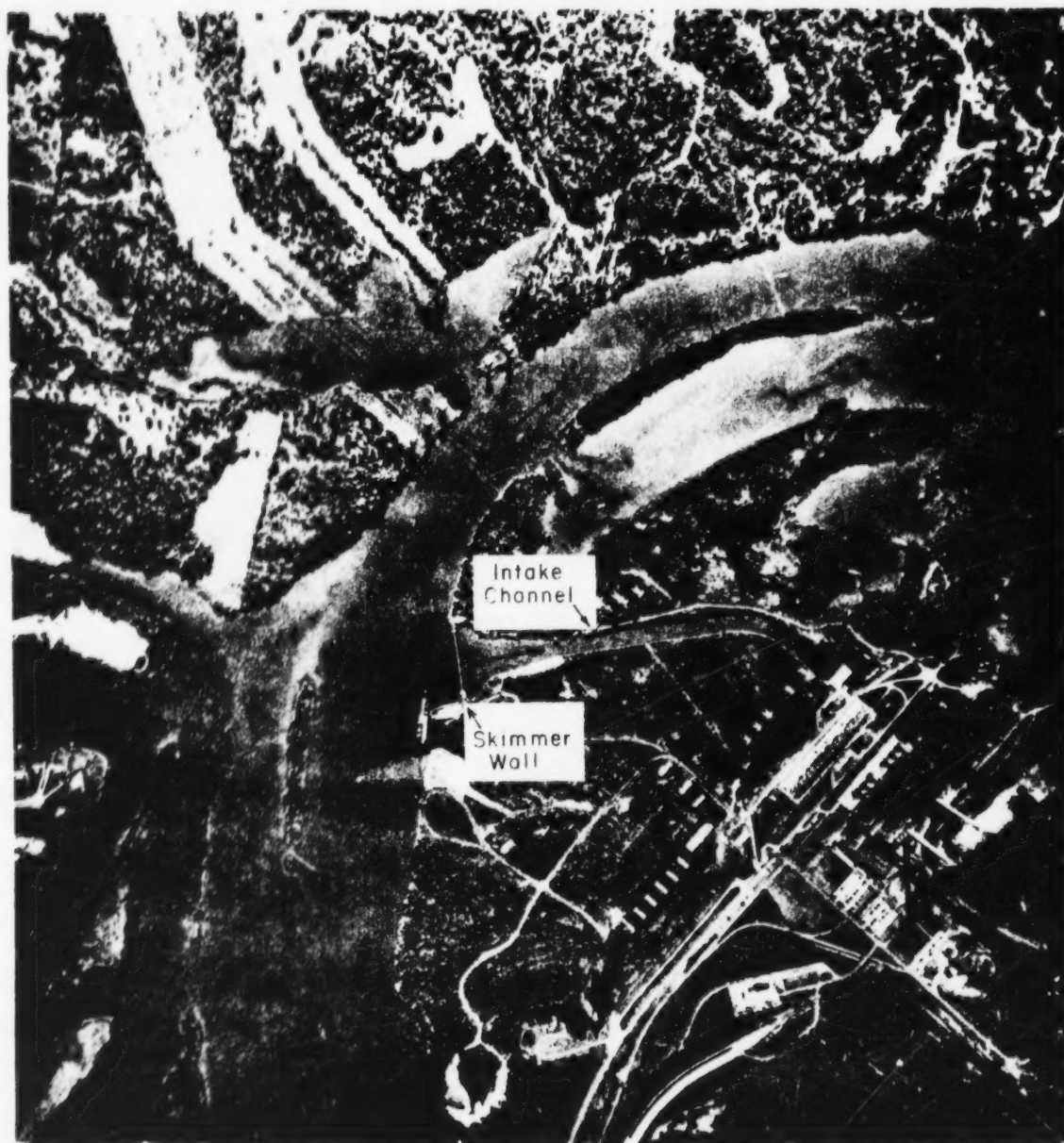


Figure 3: Cumberland River in the Vicinity of
TVA Gallatin Steam Plant

COMPUTER MODEL DESCRIPTION

Certain features are essential to a computer model designed to predict flows near a plant intake. Naturally, the topography must be simulated to a reasonable degree of accuracy. Because the water intake to the Gallatin Steam Plant is situated on the inside of a large river bend, the effects of the centrifugal force of the river flowing around the bend can be important, especially at high river flows. Use of an orthogonal curvilinear coordinate system in which the radius of curvature of the river varied as a function of longitudinal position in the river, provided a good representation of the river topography. The centrifugal force was implicitly included in the basic equations by using this coordinate system.

The intake channel was simulated as a separate region whose boundary at one end was adjacent to the river. A free exchange of flow between the river and intake channel was permitted under the skimmer wall as required to satisfy the solution of the basic governing equations. At the other end of the intake channel, the flow rate pumped into the plant was specified.

Flows in the vicinity of the skimmer wall are fully three-dimensional; therefore, an adequate mathematical description of this flow must simultaneously allow for the free exchange of mass, momentum and energy in all three directions. This required the use of the conservation of mass, momentum and energy equations in three directions. The isothermal assumption of this particular analysis eliminated the need for solving the conservation of energy equation.

Flows of such large scale phenomena are almost always turbulent. The frictional effects of the turbulence were included in this model through eddy viscosity coefficients computed from mixing length theory. The coefficients varied throughout the region as a function of local velocity gradients and distance from the surface and bottom. The temporal and spatial variations of the eddy coefficients produced the greatest effects of turbulence where the velocity gradients were large and the scale of the turbulence was not confined by a boundary. Conversely, turbulence effects were minimal where adjacent to a boundary and under quiescent conditions. Stratification which would normally suppress mixing was not a factor because of the isothermal assumption.

The conservation equations describing the flow and the solution procedure are presented in Reference 1. The numerical technique for solving these equations is an unsteady, three-dimensional, finite-difference procedure. Variable grid spacing and constant adjustment of the free surface height are included in this model. Previous applications of this computer model are presented in References 2-4.

RESULTS

Flows during the biological sampling period were highly transient as previously discussed. Instead of computing flows throughout the entire diel period, selected flows were simulated to define flow patterns representative of the various flow regimes. This was possible since flows in the vicinity of the intake usually adjust to a quasi-steady state condition on a time scale much shorter than changes in river flows near the plant. The data presented in Figure 2 indicates plateaus at river flows of about $110 \text{ m}^3/\text{sec}$ ($4000 \text{ ft}^3/\text{sec}$), $220 \text{ m}^3/\text{sec}$ ($8000 \text{ ft}^3/\text{sec}$), and $510 \text{ m}^3/\text{sec}$ ($18000 \text{ ft}^3/\text{sec}$).

Velocity vectors are shown at three depths in plan view in Figures 4, 5, and 6 for each flow case. For the two higher flows, the downstream momentum retained immediately inside of the intake channel carried the flow toward the downstream bank of the channel. This produced a disproportional amount of flow toward the plant along the downstream bank of the channel. This is shown at all three depths. In the low flow case, the flow is more evenly distributed since there is less downstream momentum.

In the $110 \text{ m}^3/\text{sec}$ ($4000 \text{ ft}^3/\text{sec}$) and $220 \text{ m}^3/\text{sec}$ ($8000 \text{ ft}^3/\text{sec}$) cases, the downstream momentum of the river also caused a quiescent flow region in the upper strata adjacent to the plant side of the skimmer wall as shown in the views of the surface in Figure 4 and at 6 m (20 ft) in Figure 5. Although TVA biologists did not sample in this region, biological sampling in such a quiescent region can produce anomalies. For the high river flow case, velocities were also very low near the surface immediately behind the skimmer wall. However, be-

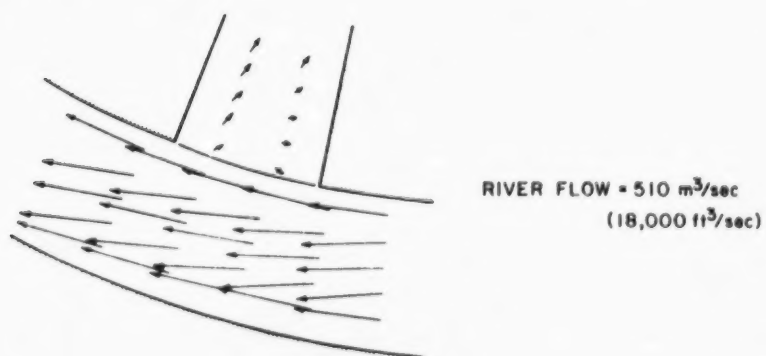
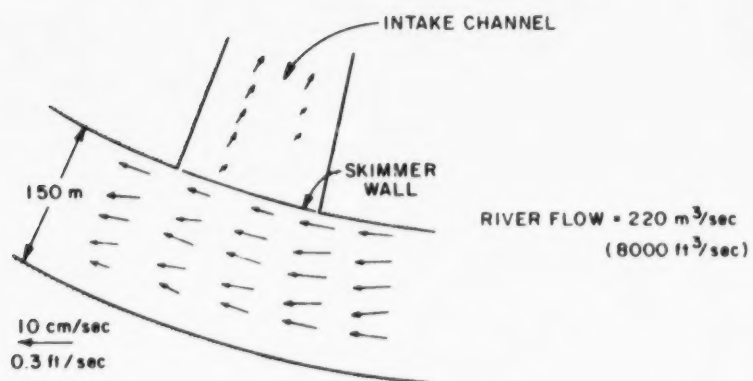


Figure 4 : Plan View of Velocity Vectors Near the Surface

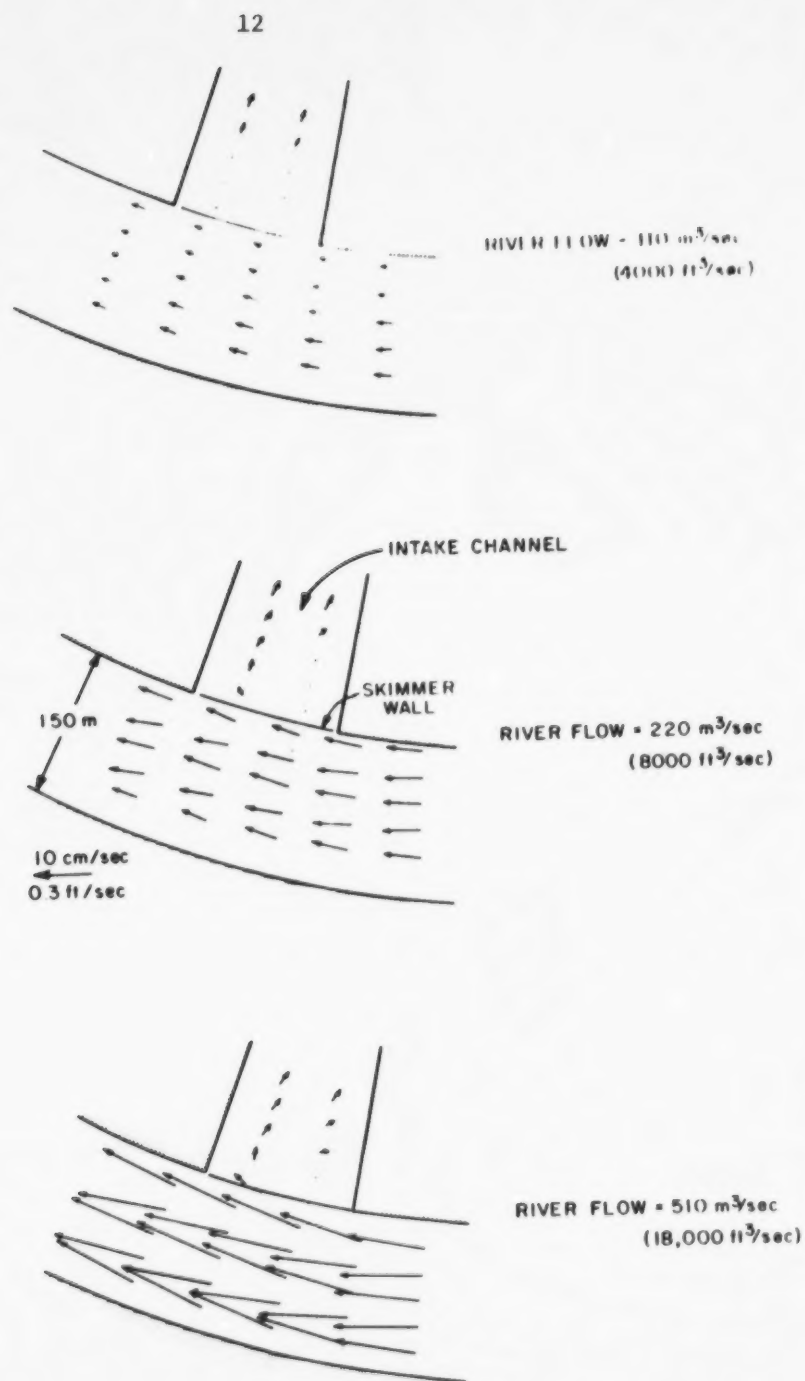
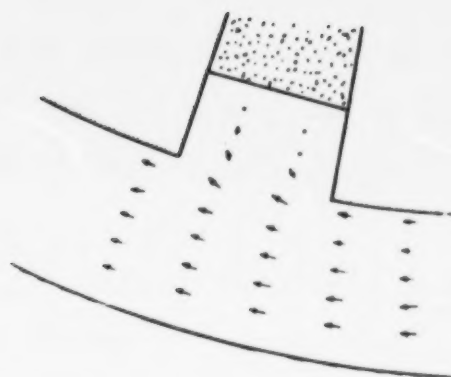
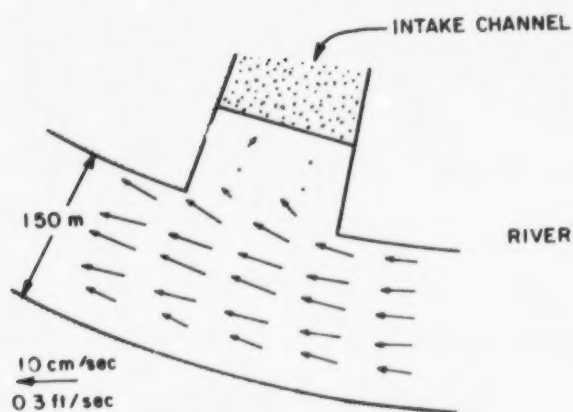


Figure 5 : Plan View of Velocity Vectors at a Depth of 6 METERS

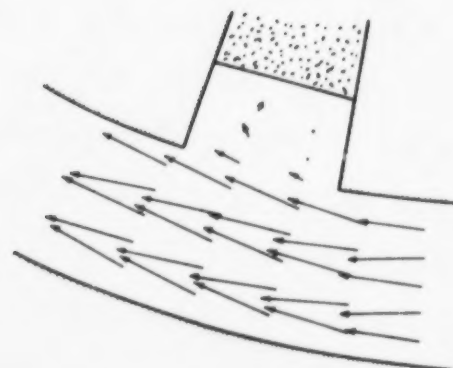
13



RIVER FLOW = $110 \text{ m}^3/\text{sec}$
(4000 ft^3/sec)



RIVER FLOW = $220 \text{ m}^3/\text{sec}$
(8000 ft^3/sec)



RIVER FLOW = $510 \text{ m}^3/\text{sec}$
(18,000 ft^3/sec)

Figure 6 : Plan View of Velocity Vectors at a Depth of 11 METERS

cause of the higher downstream momentum associated with high river flows, the general level of circulation was greater than for the two lower flows this was therefore not classified as a quiescent zone in relation to biological sampling.

Lateral views of the river and intake channel (facing upstream in the river) are presented in Figure 7. The exploded view of the river 40 m (130 ft) upstream of the skimmer wall reveals a slight rotation where the flow near the surface is generally to the right and in the opposite direction near the bottom. There are two possible causes--the rolling effect of a river bend or the anticipation of withdrawal of water under the skimmer wall immediately downstream. In the cross-sectional views in the vicinity of the intake channel, the rolling pattern of the river persists. The dead zone near the surface on the upstream side of the intake channel and adjacent to the skimmer wall is again apparent; as are the higher flows along the bank on the downstream side of the intake channel.

Distributions of flow under the skimmer wall for the three river flow cases are presented in Figure 8. It should be noted that the lower cells are approximately 50 percent larger than the top cells. Comparing the results in this figure reveals that the rate of river flow and resulting downstream momentum affect the distribution of flow under the skimmer wall. At the higher flow rates, a larger proportion of water comes from the lower depths reflecting an ample supply. At the lower flows, there is more of a tendency to entrain water from the upper layers which increases the proportion of flow through the upper cells. A comparison of the nominal and high flow cases also indicates a greater proportion of flow on the downstream side for the higher flows.

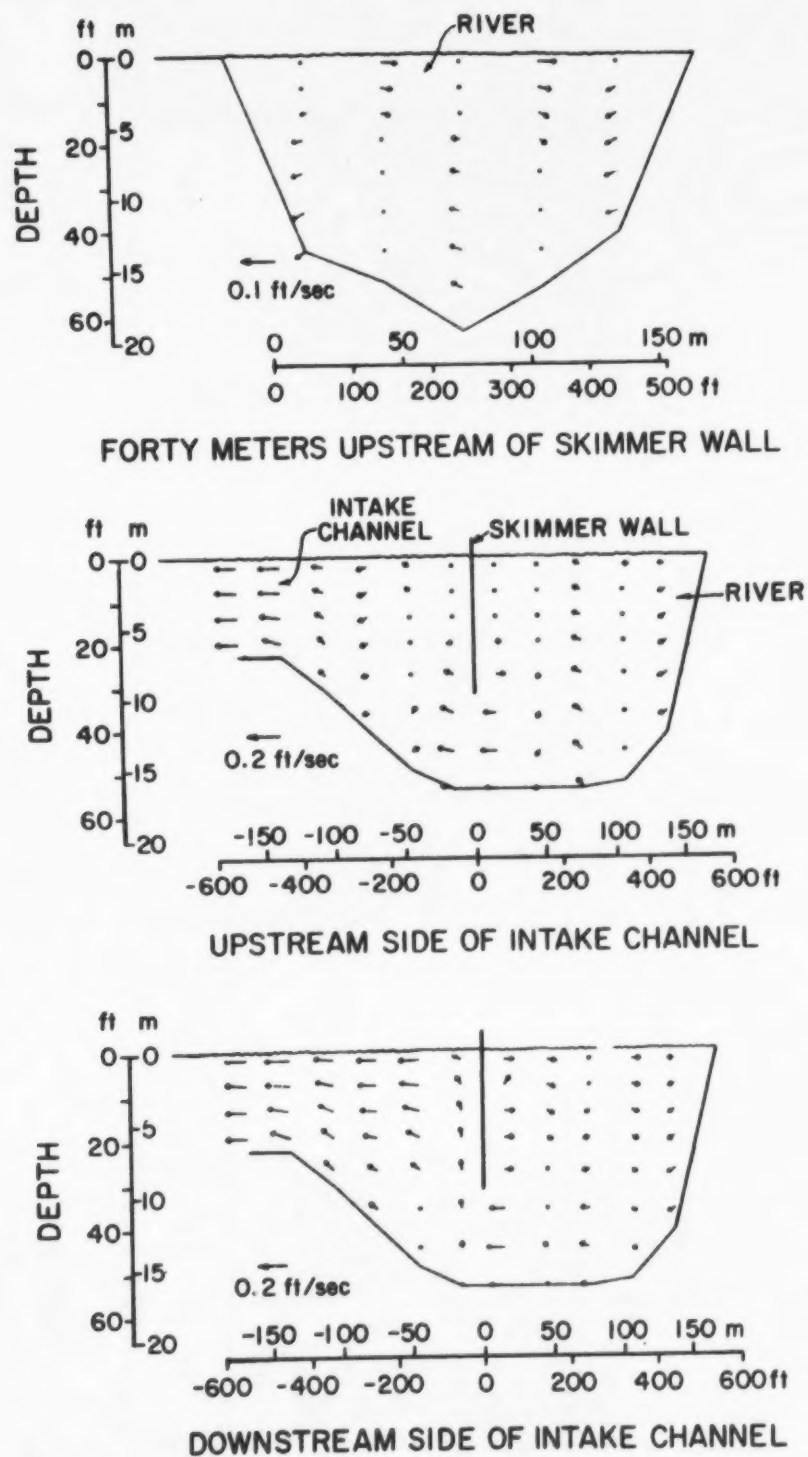


Figure 7: End View of Velocity Vectors Near the Intake

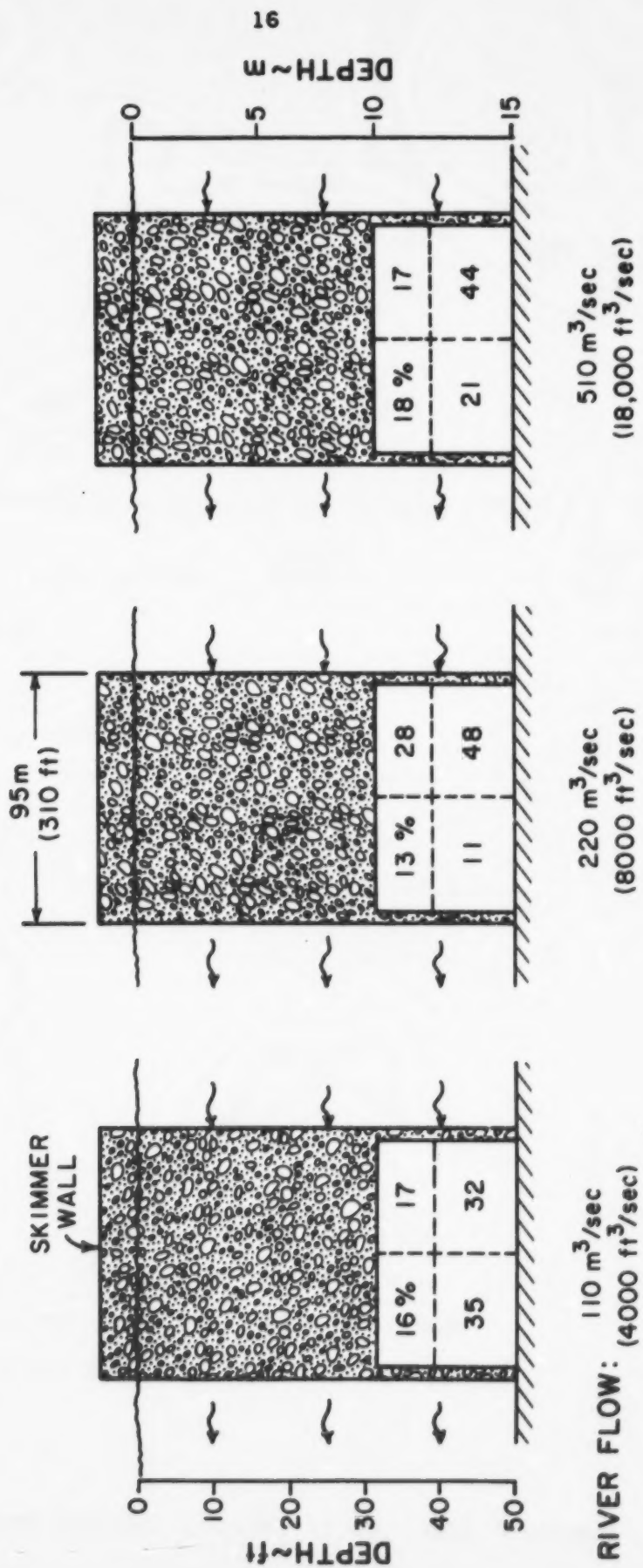


Figure 8 : Distribution of Flow Under Skimmer Wall

Under much higher river flow conditions, field experiments have revealed flow returning to the river on the upstream side of the skimmer wall.

These results are consistent with the following qualitative description of flow into a submerged intake of this type. At the extreme condition of no river flow, equal quantities of water are entrained into the intake from each side. There is also a strong tendency to entrain water from the upper layers. This tendency is counteracted by buoyancy if stratification is present. As flows increase, more water becomes available to supply the intake demand from the upstream side, and the tendency to pull from above begins to diminish. At higher flows, the downstream momentum becomes significant; no water is entrained from the river downstream of the skimmer wall because a sufficient quantity is available from the upstream side to supply the demand. At still higher flows, much of the downstream momentum is maintained as the flow enters the intake channel creating a large horizontal eddy behind the skimmer wall. This large eddy can force flow from the intake channel back into the river at the upstream end of the skimmer wall. These phenomena are not only logical, but have been recorded during field investigations.

CONCLUSIONS

Because of the unsteady operation of the upstream and downstream hydroelectric plants, flow in the Cumberland River was very unsteady during the diel period of sampling for the entrainment of plankton into the intake channel of the TVA Gallatin Steam Plant. A one-dimensional flow routing computer model indicated that flows ranged between $17 \text{ m}^3/\text{sec}$ ($600 \text{ ft}^3/\text{sec}$) and $540 \text{ m}^3/\text{sec}$ ($19,000 \text{ ft}^3/\text{sec}$). However the flows reached temporary plateaus at $110 \text{ m}^3/\text{sec}$ ($4000 \text{ ft}^3/\text{sec}$), $220 \text{ m}^3/\text{sec}$ ($8000 \text{ ft}^3/\text{sec}$), and $510 \text{ m}^3/\text{sec}$ ($18,000 \text{ ft}^3/\text{sec}$). Three-dimensional flow patterns at these flow rates were analyzed as quasi-steady state conditions with a finite difference computer model of the intake channel, the skimmer wall, and the river in the vicinity of the plant.

Results from the computer model showed a quiescent zone near the surface of the intake immediately behind the skimmer wall on the upstream end. Although TVA biologists did not sample in this region, biological sampling in such a zone can produce anomalies for the low and nominal flow cases. At the higher river flow condition, the general circulation produced by the downstream momentum of the river probably alleviated this possibility.

At low river flows, there was a stronger tendency to entrain water from the upper layers, but as flows increased, there was eventually an ample supply available in the lower layers. At higher river flows, some of the downstream momentum of the river was retained as water passed under the skimmer wall and forced most of the flow into the intake channel along the downstream bank.

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APPENDIX F

DATA (no./m³) FOR SAMPLE SETS COLLECTED
SEPTEMBER 20, 1977 (DIEL STUDY), FROM
GALLATIN STEAM PLANT INTAKE AREA

TABLE F.1. DATA (no./m³) FOR SAMPLE SETS COLLECTED SEPTEMBER 20, 1977 (DIEL STUDY),
FROM GALLATIN STEAM PLANT INTAKE AREA--TOTAL ZOOPLANKTON

Watermass sampled	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
Watermass 1 (before sunrise)				
0.5-m depth				
1	5,760	73,298	71,824	65,258
2	27,048	165,200	36,960	67,402
3	11,200	57,888	76,514	143,600
x	14,669	98,795	61,766	92,087
s	11,060	58,022	21,610	44,625
c	75.4	58.7	35.0	48.6
4-m depth				
1	54,100	147,000	134,800	
2	37,280	166,560	92,800	
3	8,500	147,600	105,800	
x	33,293	153,720	111,133	
s	23,059	11,124	21,502	
c	69.3	7.2	19.3	
8-m depth				
1	35,200	138,800		
2	44,400	92,800		
3	13,320	139,600		
x	30,973	123,733		
s	15,965	26,792		
c	51.5	21.7		
12-m depth				
1	31,520	60,434		
2	33,520	70,484		
3	31,200	63,784		
x	32,080	64,901		
s	1,257	5,117		
c	3.9	7.9		

TABLE F.1 (continued)

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
16-m depth				
1	8,980			
2	48,800			
3	10,300			
-x	22,693			
s	22,619			
c	99.7			
Watermass 2 (after sunrise)				
0.5-m depth				
1	32,640	97,800	104,000	38,320
2	10,540	91,600	48,300	33,520
3	3,880	95,000	59,898	32,320
-x	12,353	94,800	70,733	34,720
s	17,648	3,105	29,388	3,175
c	143.0	3.3	41.5	9.1
4-m depth				
1	14,720	177,600	77,200	
2	15,220	152,800	67,000	
3	33,920	219,200	37,120	
-x	21,287	183,200	60,440	
s	10,944	33,552	20,830	
c	51.4	18.3	34.5	
8-m depth				
1	33,680	96,400		
2	57,400	157,600		
3	46,200	130,200		
-x	45,760	128,067		
s	11,866	30,656		
c	25.9	23.9		

TABLE F.1 (continued)

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
12-m depth				
1	8,240	73,968		
2	34,240	71,556		
3	9,810	140,200		
-x	17,430	95,241		
s	14,579	38,954		
c	83.6	40.9		
16-m depth				
1	5,560			
2	8,420			
3	46,100			
-x	20,027			
s	22,625			
c	113.0			
Watermass 3 (noon)				
0.5-m depth				
1	46,300	119,400	82,800	73,968
2	32,480	166,000	77,074	82,200
3	35,920	172,000	104,899	69,206
-x	38,233	152,467	88,258	75,125
s	7,195	28,792	14,693	6,574
c	18.8	18.9	16.6	8.8
4-m depth				
1	74,638	141,000	166,000	
2	93,000	257,200	94,400	
3	78,792	201,200	62,258	
-x	82,143	199,800	107,553	
s	9,629	58,113	53,107	
c	11.7	29.1	49.4	

TABLE F.1 (continued)

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
8-m depth				
1	62,310	142,034		
2	46,100	61,506		
3	104,400	186,000		
-x	70,937	129,845		
s	30,092	63,139		
c	42.4	48.6		
12-m depth				
1	33,040	160,000		
2	43,600	98,400		
3	10,900	90,800		
-x	29,180	116,400		
s	16,688	37,949		
c	57.2	32.6		
16-m depth				
1	9,080			
2	30,080			
3	38,560			
-x	25,907			
s	15,177			
c	58.6			
Watermass 4 (before sunset)				
0.5-m depth				
1	33,840	49,100	50,900	64,320
2	10,600	58,424	73,432	56,330
3	11,380	82,008	27,360	53,332
-x	18,607	63,177	50,564	57,994
s	13,198	16,961	23,038	5,680
c	71.0	26.8	45.6	9.8

TABLE F.1 (continued)

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
4-m depth				
1	42,360	138,600	54,806	
2	1,020	130,000	59,764	
3	38,720	110,000	56,600	
-x	27,367	126,200	57,057	
s	22,889	14,674	2,510	
c	83.6	11.6	4.4	
8-m depth				
1	74,504	132,000		
2	51,700	87,800		
3	63,114	101,000		
-x	63,106	106,933		
s	11,402	22,690		
c	18.1	21.2		
12-m depth				
1	43,300	107,600		
2	66,012	83,000		
3	45,700	68,072		
-x	51,671	86,224		
s	12,478	19,960		
c	24.1	23.1		
16-m depth				
1	40,300			
2	32,800			
3	42,800			
-x	38,633			
s	5,204			
c	13.5			

TABLE F.1 (continued)

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--30 m
Watermass 5 (after sunset)				
0.5-m depth				
1	45,400	64,722	45,400	31,760
2	37,440	37,360	65,928	48,000
3	33,440	73,030	61,640	55,476
-x	38,760	58,371	57,656	45,079
s	6,038	18,664	10,828	12,125
c	15.7	32.0	18.8	26.9
4-m depth				
1	46,000	94,800	53,198	
2	65,660	103,800	65,794	
3	32,800	88,000	74,102	
-x	48,153	95,533	64,365	
s	16,536	7,296	10,525	
c	34.3	8.3	16.4	
8-m depth				
1	68,206	98,400		
2	59,630	100,232		
3	65,660	110,000		
-x	64,499	102,877		
s	4,404	6,236		
c	6.8	6.1		
12-m depth				
1	36,324	69,814		
2	49,600	79,200		
3	46,400	78,600		
-x	44,108	75,871		
s	6,928	5,254		
c	15.7	6.9		

TABLE F.1 (continued)

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
16-m depth				
1	35,680			
2	35,280			
3	39,920			
-x	36,960			
s	2,571			
c	7.0			
Watermass 6 (midnight)				
0.5-m depth				
1	35,680	39,900	57,090	41,900
2	7,340	42,400	61,506	35,520
3	10,920	47,100	42,300	5,040
-x	17,980	43,133	53,632	27,487
s	15,433	3,656	10,059	19,699
c	85.8	8.5	18.8	71.7
4-m depth				
1	39,600	84,200	62,310	
2	44,900	60,702	13,668	
3	44,200	66,866	46,900	
-x	42,900	70,589	40,959	
s	2,879	12,184	24,859	
c	6.7	17.3	60.7	
8-m depth				
1	42,600	77,050		
2	36,480	58,692		
3	48,700	73,164		
-x	42,593	69,635		
s	6,110	9,674		
c	14.3	13.9		

TABLE F.1 (continued)

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
12-m depth				
1	43,400	84,600		
2	47,500	77,586		
3	54,538	60,300		
-x	48,479	74,162		
s	5,633	12,507		
c	11.6	16.9		
16-m depth				
1	47,100			
2	11,960			
3	32,640			
-x	30,567			
s	17,662			
c	57.8			

^a Numbers (1,2,3) indicate replicate number; $\bar{x}$ = mean; s = standard deviation; and c = coefficient of variation ($c = s/\bar{x} \times 100$).

TABLE F.2. DATA (no./m³) FOR SAMPLE SETS COLLECTED SEPTEMBER 20, 1977 (DIEL STUDY),
FROM GALLATIN STEAM PLANT INTAKE AREA--ROTIFERA

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
Watermass 1 (before sunrise)				
0.5-m depth				
1	3,640	64,990	66,330	55,342
2	18,728	138,400	31,920	60,702
3	7,100	50,384	65,794	130,600
x	9,823	84,591	54,681	82,215
s	7,904	47,169	19,714	41,989
c	80.5	55.8	36.1	51.1
4-m depth				
1	45,100	130,200	115,800	
2	32,720	153,600	81,200	
3	5,940	135,600	90,200	
x	27,920	139,800	95,733	
s	20,016	12,252	17,951	
c	71.7	8.8	18.8	
8-m depth				
1	29,600	126,200		
2	37,800	83,200		
3	10,580	129,200		
x	25,993	112,867		
s	13,964	25,736		
c	53.7	22.8		
12-m depth				
1	25,760	53,466		
2	25,440	57,218		
3	23,440	53,600		
x	24,880	54,761		
s	1,257	2,129		
c	5.1	3.9		

TABLE F.2 (continued)

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
16-m depth				
1	6,920			
2	37,400			
3	7,240			
-x	47,187			
s	17,506			
c	101.9			
Watermass 2 (after sunrise)				
0.5-m depth				
1	28,960	94,800	88,000	29,920
2	8,440	85,400	39,500	29,120
3	3,040	91,400	52,394	27,120
-x	13,480	90,533	59,965	28,720
s	13,675	4,760	25,121	1,442
c	101	5.3	41.9	5.0
4-m depth				
1	9,760	160,800	68,200	
2	12,160	136,000	59,094	
3	29,840	207,600	29,600	
-x	17,253	168,133	52,298	
s	10,966	36,359	20,171	
c	63.6	21.6	38.6	
8-m depth				
1	28,240	87,600		
2	46,400	145,600		
3	36,300	118,800		
-x	36,980	117,333		
s	9,099	29,028		
c	24.6	24.7		

TABLE F.2 (continued)

Watermass sampled	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
12-m depth				
1	5,360	64,454		
2	25,120	59,094		
3	6,070	127,400		
-x	12,183	83,649		
s	11,209	37,984		
c	92.0	45.4		
16-m depth				
1	3,500			
2	5,440			
3	34,800			
-x	14,580			
s	17,538			
c	120.3			
Watermass 3 (noon)				
0.5-m depth				
1	42,300	114,200	74,200	60,970
2	29,680	163,600	67,560	71,200
3	33,520	166,400	90,699	55,290
-x	35,167	148,067	77,486	63,487
s	6,469	29,363	11,914	6,813
c	18.4	19.8	15.4	10.7
4-m depth				
1	63,516	129,400	153,600	
2	82,800	229,600	86,600	
3	70,082	179,600	58,022	
-x	72,133	179,533	99,407	
s	9,804	50,100	49,059	
c	13.6	27.9	49.4	

TABLE F.2 (continued)

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
8-m depth				
1	51,590	125,034		
2	37,300	53,600		
3	85,800	160,800		
-x	58,230	113,145		
s	24,923	54,580		
c	42.8	48.2		
12-m depth				
1	25,040	146,400		
2	33,900	85,600		
3	6,900	81,000		
-x	21,953	104,333		
s	13,752	36,503		
c	62.6	35.0		
16-m depth				
1	5,440			
2	20,400			
3	29,360			
-x	18,400			
s	12,085			
c	65.7			
Watermass 4 (before sunset)				
0.5-m depth				
1	30,160	42,100	45,700	56,414
2	9,060	51,724	61,372	46,830
3	9,620	76,246	21,060	46,900
-x	16,280	56,690	42,711	50,048
s	12,024	17,606	20,322	5,513
c	73.9	31.1	47.6	11.0

TABLE F.2 (continued)

Watermass sampled	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
4-m depth				
1	32,960	125,000	45,962	
2	840	118,400	50,652	
3	32,640	99,000	47,400	
$\bar{x}$	22,147	114,133	48,005	
s	18,453	13,515	2,403	
c	83.3	11.8	5.0	
8-m depth				
1	58,424	108,600		
2	40,900	74,600		
3	46,632	89,600		
$\bar{x}$	48,652	90,933		
s	8,935	17,039		
c	18.4	18.7		
12-m depth				
1	32,000	75,800		
2	39,798	72,800		
3	32,300	56,548		
$\bar{x}$	34,699	68,383		
s	4,418	10,358		
c	12.7	15.1		
16-m depth				
1	30,400			
2	22,800			
3	31,200			
$\bar{x}$	28,133			
s	4,636			
c	16.5			

TABLE F.2 (continued)

Watermass sampled	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
Watermass 5 (after sunset)				
0.5-m depth				
1	35,900	58,156	37,300	22,560
2	29,600	30,480	53,734	34,800
3	24,080	63,650	47,034	43,952
x	29,860	50,762	46,023	33,771
s	5,914	17,778	8,264	10,733
c	19.8	35.0	18.0	81.8
4-m depth				
1	32,900	83,000	40,602	
2	51,992	89,400	54,404	
3	23,600	78,200	61,238	
x	36,164	83,600	52,081	
s	14,475	5,611	10,512	
c	40.0	6.7	20.2	
8-m depth				
1	53,466	84,800		
2	42,880	80,936		
3	44,622	96,400		
x	46,989	87,379		
s	5,676	8,048		
c	12.1	9.2		
12-m depth				
1	23,844	54,538		
2	35,900	63,400		
3	36,400	65,400		
x	32,048	61,113		
s	7,109	5,781		
c	22.2	9.5		

TABLE F.2 (continued)

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
16-m depth				
1	25,920			
2	24,320			
3	26,960			
-x	25,733			
s	1,330			
c	5.2			
Watermass 6 (midnight)				
0.5-m depth				
1	25,280	30,700	43,020	32,500
2	4,580	33,500	45,024	23,840
3	5,720	36,800	30,200	2,220
-x	11,860	33,667	39,415	19,520
s	11,636	3,053	8,043	15,595
c	98.1	9.1	20.4	79.9
4-m depth				
1	26,600	62,200	45,560	
2	28,600	44,890	41,064	
3	32,200	50,250	32,200	
-x	29,133	52,447	39,608	
s	2,838	8,862	6,798	
c	9.7	16.9	17.2	
8-m depth				
1	27,800	57,620		
2	22,160	41,540		
3	32,700	53,466		
-x	27,553	50,875		
s	5,274	8,347		
c	19.1	16.4		

TABLE F.2 (continued)

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
12-m depth				
1	28,600	65,000		
2	31,900	51,322		
3	36,314	46,498		
$\bar{x}$	32,271	54,273		
s	3,870	9,598		
c	12.0	17.7		
16-m depth				
1	30,300			
2	5,920			
3	20,240			
$\bar{x}$	18,820			
s	12,252			
c	65.1			

^a Numbers (1,2,3) indicate replicate number; $\bar{x}$ = mean; s = standard deviation; and c = coefficient of variation ($c = s/\bar{x} \times 100$).

TABLE F.3. DATA (no./m³) FOR SAMPLE SETS COLLECTED SEPTEMBER 20, 1977 (DIEL STUDY),
FROM GALLATIN STEAM PLANT INTAKE AREA--*Brachionus angularis*

Watermass sampled	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
Watermass 1 (before sunrise)				
0.5-m depth				
1	1,340	20,502	19,698	17,956
2	5,280	33,600	12,080	20,502
3	2,260	20,770	24,120	48,400
-x	2,960	24,957	18,633	28,953
s	2,061	7,486	6,090	16,890
c	69.6	30.0	32.7	58.3
4-m depth				
1	7,400	44,400	40,000	
2	5,680	58,000	24,000	
3	1,860	43,800	32,600	
-x	4,980	48,733	32,667	
s	2,836	8,031	7,905	
c	56.9	16.5	24.5	
8-m depth				
1	6,160	39,800		
2	7,200	30,000		
3	2,340	41,600		
-x	5,233	37,133		
s	2,559	6,243		
c	48.9	16.8		
12-m depth				
1	4,880	18,358		
2	2,720	19,430		
3	3,440	16,080		
-x	3,680	17,956		
s	1,100	1,711		
c	29.9	9.5		

TABLE F.3 (continued)

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
16-m depth				
1	1,080			
2	4,900			
3	1,320			
-x	2,433			
s	2,140			
c	88.0			
Watermass 2 (after sunrise)				
0.5-m depth				
1	7,200	29,400	29,800	9,840
2	2,400	22,600	10,300	8,640
3	640	28,000	18,224	8,880
-x	3,413	26,667	19,441	9,120
s	3,395	3,591	9,807	635
c	99.5	13.5	50.4	7.0
4-m depth				
1	2,560	37,600	20,200	
2	2,740	40,000	20,904	
3	6,400	62,400	7,840	
-x	4,000	46,667	16,315	
s	2,079	13,678	1,348	
c	52.0	29.3	45.0	
8-m depth				
1	5,360	26,400		
2	9,100	54,400		
3	7,500	32,600		
-x	7,320	37,800		
s	1,876	14,706		
c	25.6	38.9		

TABLE F.3 (continued)

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
12-m depth				
1	2,620	18,492		
2	3,920	17,018		
3	3,300	34,800		
$\bar{x}$	3,280	23,437		
s	650	9,969		
c	19.8	42.1		
16-m depth				
1	600			
2	1,200			
3	5,800			
$\bar{x}$	2,533			
s	2,845			
c	112.3			
Watermass 3 (noon)				
0.5-m depth				
1	9,700	29,600	28,000	28,676
2	5,920	33,600	27,604	34,200
3	6,640	40,000	42,200	29,748
$\bar{x}$	7,420	34,400	32,601	30,875
s	2,007	5,246	8,315	2,929
c	27.1	15.2	25.5	9.5
4-m depth				
1	15,812	46,000	42,400	
2	18,600	59,200	29,800	
3	15,544	70,400	21,306	
$\bar{x}$	16,652	58,533	31,169	
s	1,692	12,214	10,613	
c	10.2	20.9	34.1	

TABLE F.3 (continued)

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
8-m depth				
1	11,658	47,200		
2	9,400	21,440		
3	20,400	60,400		
-x	13,819	43,013		
s	5,810	19,815		
c	42.0	46.1		
12-m depth				
1	6,400	30,000		
2	7,700	25,600		
3	1,860	24,000		
-x	5,320	27,533		
s	3,066	3,107		
c	57.6	11.7		
16-m depth				
1	1,400			
2	5,040			
3	10,800			
-x	5,747			
s	4,740			
c	82.5			
Watermass 4 (before sunset)				
0.5-m depth				
1	7,440	8,000	15,900	13,534
2	1,740	9,648	17,554	13,300
3	1,920	17,822	7,420	18,894
-x	3,700	11,890	13,625	15,243
s	3,240	5,188	5,437	3,164
c	87.6	43.6	39.9	20.8

TABLE F.3 (continued)

Watermass sampled ^d	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
4-m depth				
1	5,800	30,600	13,266	
2	160	24,000	11,122	
3	6,240	19,000	15,600	
-x	4,067	24,533	13,309	
s	3,390	5,818	2,240	
c	83.4	23.7	16.8	
8-m depth				
1	12,060	40,400		
2	9,300	23,800		
3	8,308	26,200		
-x	9,889	30,133		
s	1,944	8,972		
c	19.7	29.8		
12-m depth				
1	6,100	21,400		
2	8,174	21,600		
3	6,300	19,966		
-x	6,858	20,989		
s	1,144	891		
c	16.7	4.2		
16-m depth				
1	6,200			
2	5,280			
3	5,700			
-x	5,727			
s	461			
c	8.0			

TABLE F.3 (continued)

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
Watermass 5 (after sunset)				
0.5-m depth				
1	7,400	9,514	10,500	7,440
2	8,000	5,680	15,812	13,668
3	5,920	14,472	20,100	10,100
-x	7,107	9,889	15,471	10,403
s	1,071	4,408	4,809	3,125
c	15.1	44.6	31.1	30.0
4-m depth				
1	8,900	17,800	10,318	
2	9,916	21,400	11,524	
3	6,800	16,600	16,616	
-x	8,539	18,600	12,819	
s	1,589	2,498	3,343	
c	18.6	13.4	26.1	
8-m depth				
1	10,184	27,000		
2	8,978	25,996		
3	12,060	25,800		
-x	10,407	26,265		
s	1,553	644		
c	14.9	2.5		
12-m depth				
1	6,160	17,688		
2	7,600	14,800		
3	8,800	15,600		
-x	7,520	16,029		
s	1,322	1,491		
c	17.6	9.3		

TABLE F.3 (continued)

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
16-m depth				
1	4,880			
2	6,400			
3	6,880			
-x	6,053			
s	1,044			
c	17.2			
Watermass 6 (midnight)				
0.5-m depth				
1	3,840	9,200	11,122	10,400
2	8,640	10,300	11,926	7,840
3	1,240	12,200	10,100	1,100
-x	4,573	10,567	11,049	6,447
s	3,754	1,518	915	4,804
c	82.1	14.4	8.3	74.5
4-m depth				
1	2,160	19,200	13,906	
2	6,400	18,090	15,544	
3	8,500	14,874	9,800	
-x	5,687	17,388	13,093	
s	3,230	2,247	2,963	
c	56.8	12.9	22.6	
8-m depth				
1	9,200	13,668		
2	6,400	12,730		
3	5,840	20,904		
-x	7,147	15,767		
s	1,800	4,473		
c	25.2	28.4		

TABLE F.3 (continued)

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
12-m depth				
1	7,200	26,000		
2	7,500	18,224		
3	4,300	13,400		
$\bar{x}$	6,333	19,208		
s	1,767	6,357		
c	27.9	33.1		
16-m depth				
1	8,308			
2	4,600			
3	2,140			
$\bar{x}$	5,016			
s	3,105			
c	61.9			

^aNumbers (1,2,3) indicate replicate number; $\bar{x}$ = mean; s = standard deviation; and c = coefficient of variation ($c = s/\bar{x} \times 100$).

TABLE F.4. DATA (no./m³) FOR SAMPLE SETS COLLECTED SEPTEMBER 20, 1977 (DIEL STUDY),
FROM GALLATIN STEAM PLANT INTAKE AREA--CLADOCERA

Watermass sampled	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
Watermass 1 (before sunrise)				
0.5-m depth				
1	200	1,474	1,206	1,608
2	1,520	8,400	1,200	1,072
3	280	2,948	1,876	2,000
-x	667	4,274	1,427	1,560
s	740	3,648	389	466
c	111.0	85.4	27.2	29.9
4-m depth				
1	2,100	3,600	5,400	
2	720	3,600	3,800	
3	540	2,200	3,400	
-x	1,120	3,133	4,200	
s	854	808	1,058	
c	76.2	25.8	25.2	
8-m depth				
1	1,920	2,800		
2	1,800	2,000		
3	800	2,600		
-x	1,507	2,467		
s	615	416		
c	40.8	16.9		
12-m depth				
1	2,000	1,742		
2	2,160	3,082		
3	4,720	2,144		
-x	2,960	2,323		
s	1,526	688		
c	51.6	29.6		

TABLE F.4 (continued)

Watermass sampled	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
16-m depth				
1	460			
2	3,800			
3	560			
-x	1,607			
s	1,900			
c	118.2			
Watermass 2 (after sunrise)				
0.5-m depth				
1	800	600	2,200	1,760
2	200	1,400	1,600	1,040
3	40	1,200	2,142	1,360
-x	347	1,067	2,671	1,387
s	401	416	421	361
c	115.6	39.0	20.3	26.0
4-m depth				
1	1,000	4,400	1,400	
2	620	3,600	1,206	
3	960	2,800	720	
-x	860	3,600	1,109	
s	209	800	350	
c	24.3	22.2	31.6	
8-m depth				
1	3,200	2,000		
2	5,800	2,400		
3	3,600	3,400		
-x	3,200	2,600		
s	400	721		
c	12.5	27.7		

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
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12-m depth

1	160	1,340		
2	4,960	2,144		
3	1,420	2,400		
-x	2,180	1,961		
s	2,489	553		
c	114.2	28.2		

16-m depth

1	640			
2	480			
3	4,800			
-x	1,973			
s	2,449			
c	124.1			

Watermass 3
(noon)

0.5-m depth

1	800	1,800	2,200	2,010
2	320	400	2,010	2,000
3	560	3,200	4,000	1,474
-x	560	1,800	2,737	1,828
s	240	1,400	1,098	307
c	42.4	77.8	40.1	16.8

4-m depth

1	3,886	4,000	1,600	
2	4,400	10,000	3,000	
3	2,814	2,500	938	
-x	3,700	5,600	1,513	
s	809	3,858	536	
c	21.9	68.9	35.5	

TABLE F.4 (continued)

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--30 m
8-m depth				
1	5,092	5,400		
2	4,500	2,144		
3	8,800	12,000		
-x	6,131	6,515		
s	2,331	5,022		
c	38.0	77.1		
12-m depth				
1	4,960	3,600		
2	5,800	4,600		
3	2,040	2,600		
-x	4,267	3,600		
s	1,974	1,000		
c	46.3	27.8		
16-m depth				
1	1,340			
2	4,000			
3	2,640			
-x	2,660			
s	1,330			
c	50.0			
Watermass 4 (before sunset)				
0.5-m depth				
1	960	800	2,100	1,876
2	280	268	4,154	3,100
3	440	670	1,560	2,144
-x	560	579	2,605	2,373
s	356	277	1,369	643
c	63.5	47.9	52.6	27.1

TABLE F.4 (continued)

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
4-m depth				
1	3,800	3,600	2,814	
2	80	2,400	2,412	
3	2,320	400	2,500	
-x	1,910	2,133	2,575	
s	2,673	1,617	211	
c	139.9	75.8	8.2	
8-m depth				
1	8,978	8,400		
2	5,100	6,400		
3	8,442	6,400		
-x	7,507	7,067		
s	2,101	1,155		
c	28.0	16.3		
12-m depth				
1	6,900	4,400		
2	7,370	4,400		
3	5,200	4,690		
-x	6,490	4,497		
s	1,142	167		
c	17.6	3.7		
16-m depth				
1	5,100			
2	4,880			
3	6,300			
-x	5,427			
s	764			
c	14.1			

TABLE F.4 (continued)

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
Watermass 5 (after sunset)				
0.5-m depth				
1	3,200	1,340	2,400	3,600
2	3,760	1,130	3,618	4,700
3	3,520	2,412	3,434	5,762
x	3,493	1,624	3,151	4,687
s	281	691	657	1,081
c	8.0	42.6	20.8	23.1
4-m depth				
1	7,300	5,000	3,886	
2	6,030	6,000	4,824	
3	3,680	4,400	3,350	
x	5,670	5,333	4,020	
s	1,837	1,137	746	
c	32.4	21.3	18.6	
8-m depth				
1	8,040	3,800		
2	6,968	8,576		
3	10,988	5,600		
x	8,665	5,992		
s	2,082	2,412		
c	24.0	40.3		
12-m depth				
1	5,280	5,326		
2	5,800	4,000		
3	5,300	5,200		
x	5,460	4,809		
s	295	701		
c	5.4	14.6		

Watermass sampled	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--30 m
16-m depth:				
1	2,720			
2	4,400			
3	6,400			
x	4,507			
s	1,842			
c	40.9			
Watermass 6 (midnight)				
0.5-m depth:				
1	2,320	3,000	3,484	3,600
2	740	3,800	5,896	4,560
3	960	2,500	4,100	900
x	1,340	3,100	4,493	3,020
s	856	656	1,253	1,898
c	63.9	21.2	27.9	62.8
4-m depth				
1	4,200	6,600	6,566	
2	4,100	5,494	5,896	
3	3,600	5,762	3,900	
x	3,967	5,952	5,454	
s	322	577	1,387	
c	8.1	9.7	25.4	
8-m depth				
1	3,900	5,226		
2	4,000	4,958		
3	4,200	7,638		
x	4,033	5,940		
s	153	1,476		
c	3.8	24.9		

TABLE F.4 (continued)

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
12-m depth:				
1	3,400	5,200		
2	4,900	7,906		
3	6,834	4,154		
$\bar{x}$	5,045	5,753		
s	1,722	1,936		
c	34.1	33.7		
16-m depth:				
1	5,500			
2	1,300			
3	3,840			
$\bar{x}$	3,547			
s	2,115			
c	59.6			

^a Numbers (1,2,3) indicate replicate number; $\bar{x}$ = mean; s = standard deviation; and c = coefficient of variation ($c = s/\bar{x} \times 100$).

TABLE F.5. DATA (no./m³) FOR SAMPLE SETS COLLECTED SEPTEMBER 20, 1977 (DIEL STUDY),
FROM GALLATIN STEAM PLANT INTAKE AREA--Bosmina longirostris

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
Watermass 1 (before sunrise)				
0.5-m depth				
1	160	1,072	1,072	1,474
2	1,120	3,200	1,120	1,072
3	180	1,474	1,742	1,800
-x	487	1,915	1,311	1,449
s	549	1,131	374	365
c	112.6	59.0	28.5	25.2
4-m depth				
1	1,100	2,600	4,600	
2	480	2,800	3,000	
3	400	2,000	3,000	
-x	660	2,467	3,533	
s	383	416	924	
c	58.1	16.9	26.1	
8-m depth				
1	1,040	2,200		
2	1,500	1,600		
3	720	1,800		
-x	1,087	1,867		
s	392	306		
c	36.1	16.9		
12-m depth				
1	2,000	1,072		
2	1,680	2,144		
3	4,080	1,876		
-x	2,587	1,697		
s	1,303	558		
c	50.4	32.9		

TABLE F.5 (continued)

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
16-m depth				
1	380			
2	2,900			
3	380			
x	1,220			
s	1,455			
c	119.3			
Watermass 2 (after sunrise)				
0.5-m depth				
1	560	600	2,200	1,760
2	20	1,000	1,300	880
3	40	1,000	2,278	1,360
x	207	867	1,926	1,333
s	306	231	544	441
c	148.1	26.6	28.2	33.1
4-m depth				
1	660	1,600	1,400	
2	460	2,000	938	
3	720	1,600	560	
x	613	1,733	966	
s	136	231	421	
c	22.2	13.3	43.6	
8-m depth				
1	2,800	2,000		
2	2,400	2,000		
3	3,000	2,600		
x	2,733	2,200		
s	306	346		
c	11.2	15.7		

TABLE F.2 (CONTINUED)

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--20 m
12-m depth				
1	60	670		
2	4,480	1,474		
3	1,160	1,800		
-x	1,900	1,315		
s	2,301	582		
c	121.1	44.2		
16-m depth				
1	440			
2	280			
3	4,200			
-x	1,640			
s	2,219			
c	135.3			
Watermass 3 (noon)				
0.5-m depth				
1	800	1,400	2,200	2,010
2	320	400	2,010	1,800
3	560	2,800	4,000	1,474
-x	560	1,533	2,737	1,761
s	240	1,206	1,098	270
c	42.9	78.6	40.1	15.3
4-m depth				
1	2,948	3,400	1,600	
2	3,800	8,000	1,800	
3	2,010	2,800	804	
-x	2,919	4,733	1,401	
s	895	2,845	527	
c	30.7	60.1	37.6	

TABLE F.5 (continued)

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
8-m depth				
1	3,618	5,200		
2	3,300	2,010		
3	6,800	10,000		
$\bar{x}$	4,573	5,737		
s	1,936	4,022		
c	42.3	70.1		
12-m depth				
1	4,080	3,200		
2	5,400	4,200		
3	1,860	2,000		
$\bar{x}$	3,780	3,133		
s	1,789	1,102		
c	47.3	35.2		
16-m depth				
1	1,200			
2	3,520			
3	2,480			
$\bar{x}$	2,400			
s	1,162			
c	48.4			
Watermass 4 (before sunset)				
0.5-m depth				
1	960	700	1,600	1,608
2	180	268	3,618	2,900
3	320	670	1,220	1,742
$\bar{x}$	487	546	2,146	2,083
s	416	241	1,289	710
c	85.4	44.2	60.1	34.1

TABLE W.2 (continued)

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
4-m depth:				
1	3,200	3,200	1,742	
2	80	1,800	1,340	
3	1,920	200	2,000	
-x	1,733	1,733	1,694	
s	1,568	1,501	333	
c	90.5	86.6	19.6	
8-m depth:				
1	7,504	4,400		
2	4,400	5,000		
3	6,298	4,600		
-x	6,067	4,667		
s	1,565	306		
c	25.8	6.5		
12-m depth:				
1	5,500	3,200		
2	5,896	3,200		
3	4,200	3,216		
-x	5,199	3,205		
s	887	9		
c	17.1	0.3		
16-m depth:				
1	3,600			
2	3,120			
3	4,500			
-x	3,740			
s	701			
c	18.7			

TABLE F.5 (continued)

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
Watermass 5 (after sunset)				
0.5-m depth				
1	2,700	1,340	1,500	3,240
2	3,280	960	2,412	3,880
3	3,360	2,412	2,278	3,300
-x	3,113	1,571	2,063	3,142
s	360	753	492	834
c	11.6	47.9	23.9	26.6
4-m depth				
1	6,000	4,200	2,278	
2	5,494	6,200	3,752	
3	2,960	3,800	2,271	
-x	4,818	4,733	2,769	
s	1,629	1,286	851	
c	33.8	27.2	30.7	
8-m depth				
1	6,968	2,600		
2	5,360	7,102		
3	9,648	5,200		
-x	7,325	4,967		
s	2,166	2,260		
c	29.6	45.5		
12-m depth				
1	4,480	2,814		
2	4,700	2,400		
3	4,700	2,000		
-x	4,627	2,405		
x	127	407		
c	2.7	16.9		

TABLE F.2 (continued)

Watermass sampled	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
16-m depth				
1	2,560			
2	3,440			
3	5,600			
-x	3,867			
s	1,564			
c	40.5			
Watermass 6 (midnight)				
0.5-m depth				
1	1,440	2,400	1,742	1,800
2	1,600	1,400	2,546	1,840
3	500	1,600	2,000	320
-x	1,180	1,800	2,096	1,320
s	594	529	411	866
c	50.4	29.4	19.6	65.6
4-m depth				
1	720	2,400	3,082	
2	3,500	2,814	3,216	
3	2,700	3,082	3,500	
-x	2,307	2,765	2,933	
s	1,431	344	381	
c	62.0	12.4	13.0	
8-m depth				
1	2,400	3,082		
2	2,400	3,080		
3	2,880	4,556		
-x	2,560	3,573		
s	277	851		
c	10.8	23.8		

TABLE F.5 (continued)

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
12-m dept:				
1	2,800	2,200		
2	2,200	3,082		
3	3,300	2,278		
$\bar{x}$	2,767	2,520		
s	551	488		
c	19.9	19.-		
16-m dept:				
1	5,226			
2	3,000			
3	580			
$\bar{x}$	2,935			
s	2,324			
c	72.2			

^aNumbers (1, 2, 3) indicate replicate number; $\bar{x}$ = mean; s = standard deviation; and c = coefficient of variation ($c = s/\bar{x} \times 100$).

TABLE F.6. DATA (no./m³) FOR SAMPLE SETS COLLECTED SEPTEMBER 20, 1977 (DIEL STUDY),
FROM GALLATIN STEAM PLANT INTAKE AREA--CALANOIDA

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
Watermass 1 (before sunrise)				
0.5-m depth				
1	840	268	536	268
2	240	400	240	134
3	200	268	400	0
-x	133	312	393	134
s	92	76	148	134
c	65.5	24.4	37.7	100
4-m depth				
1	200	1,200	200	
2	400	0	0	
3	0	0	400	
-x	200	400	200	
s	200	693	200	
c	100	173.2	200	
8-m depth				
1	80	200	200	
2	200	200	200	
3	120	200	200	
-x	133	200	200	
s	60	0	0	
c	45.9	-	-	
12-m depth				
1	160	0	0	
2	80	0	0	
3	80	134	134	
-x	107	45	45	
s	46	77	77	
c	43.2	173.2	173.2	

TABLE F.6 (continued)

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
16-m depth				
1	120			
2	100			
3	40			
-x	87			
s	42			
c	47.9			
Watermass 2 (after sunrise)				
0.5-m depth				
1	0	0	0	80
2	40	200	200	0
3	0	0	134	80
-x	13	67	117	53
s	23	116	102	46
c	176.9	173.1	91.5	86.6
4-m depth				
1	240	400	0	
2	20	800	0	
3	80	0	0	
-x	113	400	0	
s	114	400	0	
c	100.9	100	-	
8-m depth				
1	0	0		
2	500	0		
3	200	200		
-x	233	67		
s	252	116		
c	108.2	173.2		

TABLE 1 (CONTINUED)

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
12-m depth				
1	0	0		
2	0	134		
3	40	200		
-x	13	111		
s	23	102		
c	176.9	91.5		
16-m depth				
1	0			
2	40			
3	300			
-x	113			
s	163			
c	144.2			
Watermass 3 (noon)				
0.5-m depth				
1	100	0	0	134
2	0	0	0	0
3	0	800	400	268
-x	33	267	133	134
s	58	462	231	134
c	175.0	173.2	173.2	100
4-m depth				
1	268	600	0	
2	800	400	0	
3	268	800	134	
-x	445	600	45	
s	307	200	77	
c	69.0	33.3	173.2	

TABLE F.6 (continued)

Watermass sampled	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
8-m depth				
1	402	400		
2	200	268		
3	1,000	0		
-x	534	223		
s	416	204		
c	77.9	91.5		
12-m depth				
1	240	0		
2	100	400		
3	40	0		
-x	127	133		
s	103	231		
c	80.8	173.2		
16-m depth				
1	20			
2	160			
3	80			
-x	87			
s	70			
c	80.7			
Watermass 4 (before sunset)				
0.5-m depth				
1	0	0	100	402
2	0	0	268	300
3	40	134	100	134
-x	13	45	156	279
s	23	77	97	135
c	176.9	173.2	62.2	48.5

TABLE F.6 (continued)

Watermass sampled	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
4-m depth				
1	200	400	0	
2	0	400	134	
3	80	0	0	
$\bar{x}$	93	217	45	
s	101	231	77	
c	108.6	865	173.2	
8-m depth				
1	134	200		
2	200	200		
3	268	0		
$\bar{x}$	201	133		
s	67	116		
c	33.4	86.6		
12-m depth				
1	100	300		
2	0	0		
3	100	134		
$\bar{x}$	67	111		
s	58	102		
c	86.6	91.9		
16-m depth				
1	0			
2	160			
3	0			
$\bar{x}$	53			
s	92			
c	17.3			

TABLE F.6 (continued)

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
Watermass 5				
(after sunset)				
0.5-m depth				
1	0	268	0	0
2	160	160	402	100
3	400	268	268	0
-x	187	232	223	33
s	201	62	205	58
c	107.7	26.9	91.7	173.2
4-m depth				
1	200	400	402	
2	134	200	134	
3	160	0	134	
-x	165	200	223	
s	33	200	155	
c	20.2	100	69.3	
8-m depth				
1	134	0	0	
2	536	536	536	
3	268	0	0	
-x	313	179	179	
s	205	310	310	
c	65.4	173.2	173.2	
12-m depth				
1	320	0	0	
2	100	600	600	
3	100	400	400	
-x	173	333	333	
s	127	306	306	
c	73.4	91.7	91.7	

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--50 m
16-m depth				
1	320			
2	240			
3	0			
-x	187			
s	167			
c	89.1			
Watermass 6 (midnight)				
0.5-m depth				
1	80	300	134	300
2	60	100	134	200
3	60	100	100	200
-x	67	167	123	100
s	12	116	20	160
c	17.3	69.3	16.0	150.0
4-m depth				
1	100	200	536	
2	200	268	268	
3	200	134	0	
-x	167	201	268	
s	58	67	268	
c	34.6	33.4	100	
8-m depth				
1	0	536		
2	160	0		
3	100	134		
-x	87	223		
s	81	279		
c	93.3	124.9		

TABLE F.6 (continued)

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
12-m depth:				
1	100	0		
2	0	134		
3	536	134		
$\bar{x}$	212	89		
s	285	77		
c	134.4	86.5		
16-m depth:				
1	100			
2	80			
3	80			
$\bar{x}$	87			
s	12			
c	13.3			

^a Numbers (1,2,3) indicate replicate number; $\bar{x}$ = mean; s = standard deviation; and c = coefficient of variation ($c = s/\bar{x} \times 100$).

TABLE F.7. DATA (no./m³) FOR SAMPLE SETS COLLECTED SEPTEMBER 20, 1977 (DIEL STUDY),
FROM GALLATIN STEAM PLANT INTAKE AREA--IMMATURE CALANOIDS

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
Watermass 1 (before sunrise)				
0.5-m depth				
1	60	268	536	268
2	240	400	160	134
3	80	268	402	0
-x	127	312	366	134
s	99	76	191	134
c	77.9	24.4	52.1	100
4-m depth				
1	200	1,200	200	
2	400	0	0	
3	0	0	400	
-x	200	400	200	
s	200	693	200	
c	100	173.2	200	
8-m depth				
1	80	200		
2	200	200		
3	120	200		
-x	133	200		
s	61	0		
c	45.8	0		
12-m depth				
1	160	0		
2	80	0		
3	80	134		
-x	107	45		
s	46	77		
c	43.3	171.9		

TABLE F.7 (continued)

Watermass sampled	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
16-m depth				
1	120			
2	100			
3	40			
-x	87			
s	42			
c	48.0			
Watermass 2 (after sunrise)				
0.5-m depth				
1	0	0	0	80
2	40	200	200	0
3	0	0	134	80
-x	13	67	111	53
s	23	115	102	46
c	173.2	172.3	91.8	87.1
4-m depth				
1	240	400	0	
2	20	800	0	
3	80	0	0	
-x	113	400	0	
s	114	400	0	
c	100.3	100	0	

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
8-m depth				
1	0	0		
2	500	0		
3	200	200		
-x	233	67		
s	252	115		
c	107.9	172.3		
12-m depth				
1	0	0		
2	0	0		
3	40	200		
-x	13	67		
s	23	115		
c	173.2	172.3		
16-m depth				
1	0			
2	40			
3	300			
-x	113			
s	163			
c	143.7			
Watermass 3 (noon)				
0.5-m depth				
1	0	0	0	0
2	0	0	0	0
3	0	800	400	268
-x	0	267	133	89
s	0	462	231	155
c	0	173.0	173.6	173.9

TABLE F.7 (continued)

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
4-m depth				
1	268	600	0	0
2	600	400	0	0
3	268	800	34	34
x	379	600	45	45
s	192	200	77	77
c	50.6	33.3	71.9	71.9
8-m depth:				
1	402	400		
2	100	268		
3	800	0		
x	434	223		
s	351	204		
c	80.9	91.4		
12-m depth				
1	240	0		
2	0	0		
3	40	0		
x	93	0		
s	129	0		
c	137.8	0		
16-m depth				
1	20			
2	160			
3	80			
x	87			
s	70			
c	81.0			

TABLE 1.1 (continued)

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
Watermass 4 (before sunset)				
0.5-m depth				
1	0	0	100	402
2	0	0	268	300
3	20	134	100	134
-x	7	45	156	279
s	12	77	97	135
c	173.2	171.9	62.2	48.5
4-m depth				
1	200	400	0	
2	0	400	134	
3	80	0	0	
-x	93	267	45	
s	101	231	77	
c	107.9	86.5	171.9	
8-m depth				
1	0	200	200	
2	200	200	200	
3	268	0	0	
-x	156	133	133	
s	139	115	115	
c	89.3	86.8		
12-m depth				
1	100	200	200	
2	0	0	0	
3	0	134	134	
-x	33	111	111	
s	58	102	102	
c	173.2	91.8		

TABLE F.7 (continued)

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
16-m depth				
1	0			
2	0			
3	0			
x	0			
s	0			
c	0			
Watermass 5 (after sunset)				
0.5-m depth:				
1	0	268	0	0
2	160	80	402	0
3	400	268	268	100
x	187	205	223	33
s	201	109	205	58
c	107.9	52.9	91.8	17.5
4-m depth:				
1	200	200	268	
2	134	200	134	
3	160	0	134	
x	165	133	179	
s	33	115	77	
c	20.2	86.8	43.2	
8-m depth				
1	134	0		
2	402	536		
3	268	0		
x	268	179		
s	134	309		
c	50.0	172.9		

TABLE F.1

Watermass sampled	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
12-m depth				
1	240	0		
2	100	600		
3	100	0		
$\bar{x}$	147	200		
s	81	346		
c	55.1	173.2		
16-m depth				
1	240			
2	240			
3	0			
$\bar{x}$	160			
s	139			
c	86.6			
Watermass 6 (midnight)				
0.5-m depth				
1	80	200	134	300
2	80	100	0	0
3	20	100	100	20
$\bar{x}$	60	133	78	107
s	35	58	70	168
c	57.7	43.4	89.3	156.8
4-m depth				
1	40	200	402	
2	100	268	268	
3	100	134	0	
$\bar{x}$	80	201	223	
s	35	67	205	
c	43.3	33.3	91.7	

TABLE F.7 (continued)

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
8-m depth				
1	0	0		
2	0	0		
3	80	134		
$\bar{x}$	27	45		
s	46	77		
c	173.2	171.9		
12-m depth				
1	100	0		
2	100	134		
3	0	134		
$\bar{x}$	67	89		
s	58	77		
c	86.6	86.9		
16-m depth				
1	134			
2	100			
3	80			
$\bar{x}$	105			
s	27			
c	26.1			

^aNumbers (1,2,3) indicate replicate number; $\bar{x}$ = mean; s = standard deviation; and c = coefficient of variation ($c = s/\bar{x} \times 100$).

TABLE F.8. DATA (no./m³) FOR SAMPLE SETS COLLECTED SEPTEMBER 20, 1977 (DIEL STUDY),
FROM GALLATIN STEAM PLANT INTAKE AREA--CYCLOPOIDA

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
Watermass 1 (before sunrise)				
0.5-m depth				
1	260	134	804	1,608
2	480	3,600	1,120	1,072
3	380	134	1,340	1,400
-x	373	1,289	1,088	1,360
s	110	2,001	269	270
c	29.5	155.2	24.8	19.9
4-m depth				
1	1,100	2,200	2,800	
2	1,040	160	1,600	
3	420	1,800	2,600	
-x	853	1,387	2,333	
s	377	1,081	643	
c	44.1	78.0	27.6	
8-m depth				
1	1,200	3,800		
2	1,400	600		
3	580	1,200		
-x	1,060	1,867		
s	428	1,701		
c	40.3	91.1		
12-m depth				
1	1,120	1,206		
2	2,240	2,680		
3	160	1,474		
-x	1,173	1,787		
s	1,041	785		
c	88.7	43.9		

TABLE F.8 (continued)

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
16-m depth				
1	400			
2	1,700			
3	780			
-x	960			
s	668			
c	69.6			
Watermass 2 (after sunrise)				
0.5-m depth				
1	560	0	4,200	1,360
2	80	400	2,200	640
3	0	600	938	1,280
-x	213	333	2,446	1,093
s	303	306	1,645	395
c	142.0	91.7	67.2	36.1
4-m depth				
1	400	1,000	2,600	
2	460	1,600	1,206	
3	320	400	1,760	
-x	393	1,067	1,855	
s	70	611	702	
c	17.9	57.3	37.8	
8-m depth				
1	560	1,600		
2	900	4,000		
3	1,300	1,200		
-x	920	2,267		
s	370	1,514		
c	40.3	66.8		

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
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12-m depth

1	700	2,412		
2	1,200	2,814		
3	650	2,600		
-x	853	2,609		
s	301	201		
c	35.3	7.7		

16-m depth

1	250			
2	600			
3	1,800			
-x	803			
s	801			
c	39.7			

Watermass 3
(noon)

0.5-m depth

1	200	200	1,600	3,216
2	240	800	1,742	2,200
3	50	0	3,400	2,742
-x	173	333	2,247	2,719
s	23	416	1,001	508
c	48.0	124.9	44.5	18.7

4-m depth

1	935	1,000	2,800	
2	600	1,200	2,200	
3	134	1,200	1,474	
-x	557	1,133	2,158	
s	404	116	664	
c	72.4	10.2	30.8	

TABLE F.8 (continued)

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
8-m depth				
1	938	2,800		
2	1,000	938		
3	8,800	1,600		
$\bar{x}$	3,579	1,779		
s	4,521	944		
c	126.3	53.0		
12-m depth				
1	640	2,000		
2	0	2,400		
3	540	2,800		
$\bar{x}$	393	2,400		
s	344	400		
c	87.5	16.7		
16-m depth				
1	660			
2	1,040			
3	2,000			
$\bar{x}$	1,233			
s	691			
c	56.0			
Watermass 4 (before sunset)				
0.5-m depth				
1	560	200	800	2,144
2	140	402	2,546	2,100
3	260	402	1,380	938
$\bar{x}$	320	335	1,575	1,727
s	216	117	889	684
c	67.6	34.8	56.4	39.6

TABLE 2.0 (continued)

Watermass sampled	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
4-m depth				
1	800	800	1,876	
2	40	1,000	2,278	
3	720	1,000	700	
$\bar{x}$	520	933	1,618	
s	418	116	820	
c	80.3	12.4	50.7	
8-m depth				
1	1,608	2,600		
2	1,700	1,600		
3	2,546	400		
$\bar{x}$	1,951	1,533		
s	517	1,102		
c	26.5	71.8		
12-m depth				
1	900	22,000		
2	3,350	1,800		
3	1,700	1,742		
$\bar{x}$	1,983	8,514		
s	1,249	11,679		
c	63.0	137.2		
16-m depth				
1	1,100			
2	1,440			
3	1,600			
$\bar{x}$	1,380			
s	255			
c	18.5			

TABLE F.8 (continued)

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
Watermass 5 (after sunset)				
0.5-m depth				
1	1,700	938	2,000	2,800
2	960	640	2,948	4,100
3	1,280	402	3,350	1,072
-x	1,313	660	2,766	2,657
s	371	269	693	1,519
c	28.3	40.7	25.1	57.2
4-m depth				
1	1,200	400	3,216	
2	1,742	1,400	2,814	
3	2,080	1,000	2,278	
-x	1,674	933	2,769	
s	444	503	471	
c	26.5	53.9	17.0	
8-m depth				
1	1,340	2,400		
2	2,680	3,216		
3	3,484	1,400		
-x	2,501	2,339		
s	1,083	910		
c	43.3	38.9		
12-m depth				
1	2,560	2,814		
2	2,500	3,600		
3	1,000	1,000		
-x	2,120	2,471		
s	711	1,333		
c	33.5	54.0		

TABLE F.C (continued)

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
16-m depth				
1	1,920			
2	2,480			
3	2,320			
$\bar{x}$	2,240			
s	288			
c	12.9			
Watermass 6 (midnight)				
0.5-m depth				
1	3,280	1,700	3,484	1,500
2	500	1,200	4,824	3,360
3	1,720	2,600	2,500	1,060
$\bar{x}$	1,833	1,833	3,603	1,973
s	1,394	710	1,167	1,221
c	76.0	38.7	32.4	61.9
4-m depth				
1	3,700	4,600	536	
2	4,300	4,422	5,360	
3	2,000	3,886	3,900	
$\bar{x}$	3,333	4,303	3,265	
s	1,193	372	2,474	
c	35.8	8.6	75.8	
8-m depth				
1	4,400	4,824		
2	4,480	4,556		
3	5,300	3,618		
$\bar{x}$	4,727	4,333		
s	498	633		
c	10.5	14.6		

TABLE F.8 (continued)

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
12-m depth:				
1	4,300	5,400		
2	4,900	6,298		
3	4,288	3,216		
$\bar{x}$	4,496	4,971		
s	350	1,585		
c	7.8	31.9		
15-m depth:				
1	6,200			
2	1,880			
3	3,920			
$\bar{x}$	4,000			
s	2,161			
c	54.0			

^a Numbers (1,2,3) indicate replicate number; $\bar{x}$ = mean; s = standard deviation; and c = coefficient of variation ($c = s/\bar{x} \times 100$).

TABLE F.9. DATA (no./m³) FOR SAMPLE SETS COLLECTED SEPTEMBER 20, 1977 (DIEL STUDY),
FROM GALLATIN STEAM PLANT INTAKE AREA--IMMATURE CYCLOPOIDS

Watermass sampled	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
Watermass 1 (before sunrise)				
0.5-m depth				
1	200	268	402	1,340
2	480	3,600	1,120	804
3	300	402	1,340	1,400
-x	327	1,423	954	1,181
s	142	1,886	491	328
c	43.4	132.6	51.4	27.8
4-m depth				
1	1,000	2,000	2,200	
2	960	160	1,000	
3	280	1,800	2,000	
-x	747	1,320	1,733	
s	405	1,010	42	
c	54.2	76.5	2.4	
8-m depth				
1	1,120	3,200		
2	1,400	600		
3	440	1,200		
-x	987	1,667		
s	494	1,361		
c	50.0	81.7		
12-m depth				
1	1,040	1,072		
2	2,160	2,412		
3	1,120	1,340		
-x	1,440	1,608		
s	625	709		
c	43.4	44.1		

TABLE F.9 (continued)

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
16-m depth				
1	300			
2	1,300			
3	760			
$\bar{x}$	787			
s	501			
c	63.6			
Watermass 2 (after sunrise)				
0.5-m depth				
1	400	0	4,000	1,200
2	60	200	1,800	640
3	0	200	938	800
$\bar{x}$	153	133	2,246	880
s	216	116	1,579	288
c	140.7	87.2	70.3	32.8
4-m depth				
1	400	400	2,600	
2	380	1,600	1,206	
3	320	400	1,200	
$\bar{x}$	367	800	1,669	
s	42	693	807	
c	11.4	86.6	48.3	
8-m depth				
1	400	1,400		
2	900	3,600		
3	1,300	1,200		
$\bar{x}$	867	2,067		
s	451	1,332		
c	52.0	64.4		

TABLE 1.7 (continued)

Watermass sampled	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
12-m depth				
1	580	2,412		
2	640	2,412		
3	480	2,000		
-x	567	2,275		
s	81	238		
c	14.3	10.5		
16-m depth				
1	220			
2	420			
3	1,600			
-x	747			
s	746			
c	99.9			
Watermass 3 (noon)				
0.5-m depth				
1	100	0	1,600	2,948
2	240	0	1,742	2,200
3	240	0	3,000	1,474
-x	193	0	2,114	2,207
s	81	0	771	737
c	41.8	0	36.5	33.4
4-m depth				
1	938	800	2,000	
2	400	1,200	1,500	
3	134	800	1,072	
-x	491	933	1,624	
s	410	231	488	
c	83.5	24.8	30.1	

TABLE F.9 (continued)

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
8-m depth:				
1	938	2,400		
2	900	804		
3	1,600	1,200		
x	1,146	1,468		
s	394	831		
c	34.3	56.6		
12-m depth				
1	480	1,200		
2	1,000	1,600		
3	460	2,400		
x	647	1,733		
s	306	611		
c	47.3	35.3		
16-m depth				
1	580			
2	960			
3	2,000			
x	1,180			
s	735			
c	62.3			
Watermass ₄ (before sunset)				
0.5-m depth				
1	560	100	800	2,144
2	100	368	2,010	1,500
3	180	268	1,280	938
x	280	212	1,363	1,527
s	246	97	609	603
c	87.8	45.8	44.7	39.5

TABLE F.7 (CONTINUED)

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--20 m
4-m depth:				
1	800	800	1,206	
2	0	800	1,608	
3	480	600	600	
-x	427	733	1,138	
s	403	115	507	
c	94.4	15.8	44.6	
8-m depth:				
1	1,474	1,800		
2	1,600	1,400		
3	2,144	400		
-x	1,739	1,200		
s	356	721		
c	20.5	60.1		
12-m depth				
1	800	1,000		
2	2,680	1,600		
3	1,400	938		
-x	1,627	1,179		
s	960	366		
c	59.0	31.0		
16-m depth				
1	1,100			
2	1,280			
3	1,500			
-x	1,293			
s	200			
c	15.5			

TABLE F.9 (continued)

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
Watermass 5 (after sunset)				
0.5-m depth				
1	1,400	670	1,900	2,080
2	720	400	2,278	3,350
3	1,200	402	2,546	3,500
-x	1,107	491	2,241	2,977
s	350	155	325	780
c	31.6	31.6	14.5	26.2
4-m depth				
1	1,000	200	2,680	
2	1,608	1,000	2,546	
3	1,440	800	2,010	
-x	1,349	667	2,412	
s	314	416	355	
c	23.3	62.4	14.7	
8-m depth				
1	1,206	2,400		
2	2,010	2,948		
3	3,484	1,200		
-x	2,233	2,183		
s	1,155	894		
c	51.7	41.0		
12-m depth				
1	2,160	2,278		
2	2,100	3,200		
3	1,300	2,800		
-x	1,853	2,759		
s	480	462		
c	25.9	16.8		

Watermass sampled	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
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16-m depth

1 1,760
2 2,320
3 2,160
-x 2,080
s 288
c 13.9

Watermass 6
(midnight)

0.5-m depth

1 3,680
2 2,320
3 1,000
-x 2,333
s 1,340
c 57.4

900
1,000
1,600
1,167
379
32.4

2,680
4,288
2,200
3,056
1,094
35.8

1,400
2,240
740
1,460
752
51.5

4-m depth

1 1,360
2 3,200
3 3,700
-x 2,753
s 1,232
c 44.8

3,800
3,886
2,680
3,455
673
19.5

134
4,422
3,100
2,552
2,196
86.0

8-m depth

1 1,700
2 4,100
3 3,920
-x 3,240
s 1,337
c 41.3

8,844
3,082
2,546
4,824
3,492
72.4

TABLE F.9 (continued)

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
12-m depth				
1	4,300	3,800		
2	3,700	5,092		
3	4,700	2,680		
$\bar{x}$	4,233	3,857		
s	503	1,207		
c	11.9	31.3		
16-m depth				
1	4,154			
2	5,600			
3	1,680			
$\bar{x}$	3,811			
s	1,982			
c	52.0			

^aNumbers (1,2,3) indicate replicate number; $\bar{x}$ = mean; s = standard deviation; and c = coefficient of variation ($c = s/\bar{x} \times 100$).

TABLE F.10. DATA (no./m³) FOR SAMPLE SETS COLLECTED SEPTEMBER 20, 1977 (DIEL STUDY),
FROM GALLATIN STEAM PLANT INTAKE AREA--NAUPLII

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
Watermass 1 (before sunrise)				
0.5-m depth				
1	1,580	6,432	2,948	6,432
2	6,080	14,400	2,480	4,422
3	3,360	4,154	7,102	9,600
-x	3,673	8,329	4,177	6,818
s	2,266	5,380	2,544	2,610
c	61.7	64.6	60.9	38.3
4-m depth				
1	5,600	9,800	10,600	
2	2,400	9,200	6,200	
3	1,600	8,000	9,200	
-x	3,200	9,000	8,667	
s	2,117	917	2,248	
c	66.1	10.2	25.9	
8-m depth				
1	2,400	5,800		
2	3,200	6,800		
3	1,240	6,400		
-x	2,280	6,333		
s	986	503		
c	43.2	7.9		
12-m depth				
1	2,480	4,020		
2	3,600	7,504		
3	2,800	6,432		
-x	2,960	5,985		
s	577	1,784		
c	19.5	29.8		

TABLE F.10 (continued)

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
16-m depth				
1	1,080			
2	5,800			
3	1,680			
$\bar{x}$	2,853			
s	2,570			
c	90.1			
Watermass 2 (after sunrise)				
0.5-m depth				
1	2,320	2,400	9,600	5,200
2	1,780	4,200	4,800	2,720
3	800	1,800	4,020	2,480
$\bar{x}$	1,633	2,800	6,140	3,467
s	771	1,249	3,022	1,506
c	47.2	44.6	49.2	43.4
4-m depth				
1	3,320	10,800	5,000	
2	1,960	10,800	5,494	
3	2,720	8,400	5,040	
$\bar{x}$	2,667	10,000	5,178	
s	682	1,386	274	
c	25.6	13.9	5.3	
8-m depth				
1	1,680	5,200		
2	6,800	5,600		
3	4,800	6,600		
$\bar{x}$	4,426	5,800		
s	2,580	721		
c	58.3	12.4		

TABLE F.10 (continued)

Watermass sampled ^a	Michannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
12-m depth:				
1	2,030	5,762		
2	2,960	7,370		
3	1,620	7,600		
-x	2,200	6,911		
s	688	1,001		
c	31.3	14.5		
16-m depth:				
1	1,140			
2	1,860			
3	4,400			
-x	2,467			
s	1,713			
c	69.4			
Watermass 3 (noon)				
0.5-m depth				
1	2,900	3,200	4,800	7,638
2	2,240	1,200	5,762	6,800
3	1,760	1,600	6,400	6,432
-x	2,300	2,000	5,654	6,957
s	572	1,058	805	618
c	24.9	52.9	14.2	8.9
4-m depth				
1	6,030	6,000	8,000	
2	4,400	16,000	3,600	
3	5,494	16,800	4,690	
-x	5,308	12,933	5,430	
s	831	6,018	2,291	
c	15.7	46.5	42.2	

TABLE F.10 (continued)

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
8-m depth				
1	4,288	8,400		
2	3,100	4,556		
3	7,000	11,600		
-x	4,796	8,185		
s	1,999	3,527		
c	41.7	43.1		
12-m depth				
1	2,160	8,000		
2	3,800	5,400		
3	1,360	4,400		
-x	2,400	5,933		
s	1,244	1,858		
c	90.2	31.3		
16-m depth				
1	1,620			
2	4,480			
3	4,480			
-x	3,527			
s	1,651			
c	46.8			
Watermass 4 (before sunset)				
0.5-m depth				
1	2,160	6,000	2,200	3,484
2	1,120	6,030	5,092	4,000
3	1,020	4,556	3,260	3,216
-x	1,433	5,529	3,517	3,567
s	631	842	1,463	399
c	44.0	15.2	41.6	11.2

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--30 m
4-m depth:				
1	4,600	8,800	4,154	
2	60	7,800	4,288	
3	2,960	9,600	6,000	
-x	2,540	8,300	4,814	
s	2,299	707	1,029	
c	90.5	8.5	21.4	
8-m depth				
1	5,360	12,200		
2	3,800	5,000		
3	5,226	4,600		
-x	4,795	7,267		
s	865	4,277		
c	18.0	58.9		
12-m depth				
1	3,400	5,200		
2	5,494	4,000		
3	6,400	4,958		
-x	5,098	4,719		
s	1,539	635		
c	30.2	13.4		
16-m depth				
1	3,700			
2	3,520			
3	3,700			
-x	3,640			
s	104			
c	2.9			

TABLE F.1C (continued)

Watermass sampled	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
Watermass (after sunset)				
0.5-m depth				
1	4,600	4,020	3,700	2,800
2	2,960	4,960	5,226	4,300
3	4,160	6,298	7,504	4,690
-x	3,907	5,093	5,477	3,930
s	849	1,145	1,914	998
c	21.7	22.5	35.0	25.4
4-m depth				
1	4,400	5,800	5,092	
2	5,762	6,000	3,618	
3	3,200	4,400	7,102	
-x	4,454	5,467	5,271	
s	1,282	945	1,749	
c	28.8	17.3	33.2	
8-m depth				
1	5,226	7,400		
2	6,566	6,968		
3	6,298	6,600		
-x	6,030	6,989		
s	709	400		
c	11.8	5.7		
12-m depth				
1	4,320	7,236		
2	5,300	7,600		
3	3,300	6,600		
-x	4,307	7,145		
s	1,000	506		
c	23.2	7.1		

TABLE F.10 (continued)

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
16-m depth				
1	4,800			
2	3,840			
3	4,240			
$\bar{x}$	4,493			
s	482			
c	11.2			
Watermass 5 (midnight)				
0.5-m depth				
1	4,720	4,200	6,968	4,000
2	1,460	3,800	5,628	3,760
3	2,460	5,100	5,400	840
$\bar{x}$	2,880	4,367	5,999	2,867
s	1,670	666	847	1,759
c	58.0	15.2	14.1	61.4
4-m depth				
1	5,000	10,600	9,112	
2	7,700	5,628	8,040	
3	6,200	6,834	6,900	
$\bar{x}$	6,300	7,687	8,017	
s	1,353	2,594	1,106	
c	21.5	33.7	13.8	
8-m depth				
1	6,500	8,844		
2	5,680	7,638		
3	6,400	8,308		
$\bar{x}$	6,193	8,263		
s	447	604		
c	7.2	7.3		

TABLE F.10 (continued)

Watermass sampled ^a	Midchannel	Front of skimmer	Back of skimmer--15 m	Back of skimmer--90 m
12-m depth				
1	7,000	9,000		
2	5,800	11,926		
3	6,566	6,298		
$\bar{x}$	6,455	9,075		
s	608	2,815		
c	9.4	31.0		
16-m depth				
1	5,000			
2	2,780			
3	4,560			
$\bar{x}$	4,113			
s	1,176			
c	28.6			

^aNumbers (1,2,3) indicate replicate number; $\bar{x}$ = mean; s = standard deviation; and c = coefficient of variation ($c = s/\bar{x} \times 100$).

APPENDIX G

DATA (no./m³) FOR SAMPLE SETS COLLECTED MAY 25, 1977,
FROM COLBERT STEAM PLANT INTAKE AREA

TABLE G.1. DATA (no./m³) FOR SAMPLE SETS COLLECTED MAY 25, 1977,
FROM COLBERT STEAM PLANT INTAKE AREA

Taxonomic group ^a	Upstream		Near intake		Intake forebay	
	Right bank	Left bank	Right bank	Left bank	Right bank	Left bank
Total zooplankton						
4 m to surface						
1	7,584	22,360	3,392	14,486	11,350	15,193
2	9,483	15,489	5,575	15,976	18,784	7,606
-x						
s	8,534	18,925	4,484	15,231	15,064	11,400
c	1,342.7	4,858.5	1,543.6	1,053.6	5,256.6	5,364.8
	15.7	25.7	34.4	6.9	34.9	47.1
8 m to surface						
1	6,436	20,962	7,548	12,974		
2	3,196	12,908	6,728	12,370		
-x						
s	4,816	16,935	7,138	12,672		
c	2,219.0	5,695.0	579.8	427.1		
	47.6	33.6	8.1	3.4		
Rotifera						
4 m to surface						
1	3,897	16,809	1,108	10,064	6,321	10,852
2	3,182	11,347	1,991	11,538	12,378	4,769
-x						
s	3,540	14,078	1,551	10,801	9,350	7,811
c	505.6	3,862.2	624.5	1,042.3	4,282.9	4,301.3
	14.3	27.4	40.3	9.6	45.8	55.1
8 m to surface						
1	2,031	14,250	2,249	8,208		
2	678	7,756	2,329	7,730		
-x						
s	1,355	11,003	2,289	7,969		
c	956.7	4,592.0	56.6	338.0		
	70.6	47.7	2.5	4.2		

TABLE G.1 (continued)

Taxonomic group ^a	Upstream		Near intake		Intake forebay	
	Right bank	Left bank	Right bank	Left bank	Set 1	Set 2
<u>Bosmina longirostris</u>						
4 m to surface						
1	0	0	20	0	86	0
2	137	72	18	148	0	0
$\bar{x}$	69	36	19	74	43	0
s	97	51	1	105	61	0
c	140.4	141.4	7.4	141.4	141.4	0
8 m to surface						
1	58	49	51	0		
2	7	94	51	0		
$\bar{x}$	33	72	51	0		
s	36	32	0	0		
c	109.3	44.2	0	0		
<u>Calanoida</u>						
4 m to surface						
1	467	310	362	224	489	145
2	412	396	833	148	495	258
$\bar{x}$	440	353	598	186	492	202
s	38.9	60.8	333.1	53.7	4.2	79.9
c	8.8	17.2	55.7	28.9	0.9	39.6
8 m to surface						
1	392	267	861	238		
2	244	234	579	469		
$\bar{x}$	318	250	720	354		
s	104.7	23.3	199.4	163.3		
c	32.9	9.3	27.7	46.1		

Taxonomic group ^a	Upstream		Near intake		Intake forebay	
	Right bank	Left bank	Right bank	Left bank	Set 1	Set 2
<i>Synchaeta</i> spp.						
4 m to surface						
1	3,592	15,722	500	8,718	5,776	10,041
2	2,595	10,627	1,694	9,578	10,520	4,227
-x	3,094	13,175	1,097	9,148	8,148	7,134
s	705	3,603	844	608	3,355	4,111
c	22.8	27.3	77.0	6.6	41.2	57.6
8 m to surface						
1	1,698	13,132	1,980	7,336		
2	501	7,170	1,968	6,959		
-x	1,100	10,151	1,974	7,148		
s	846	4,216	8	267		
c	77.0	41.5	0.4	3.7		
<i>Cladocera</i>						
4 m to surface						
1	160	39	79	416	862	550
2	649	216	90	370	527	516
-x	405	128	85	393	695	533
s	345.8	125.2	7.8	32.5	236.9	24.0
c	85.4	97.8	9.2	8.5	34.1	4.5
8 m to surface						
1	617	292	374	423		
2	50	210	335	399		
-x	334	251	355	411		
s	400.9	58.0	27.6	17.0		
c	120.0	23.1	7.8	4.1		

TABLE G.1 (continued)

Taxonomic group ^a	Upstream		Net intake		Intake forebay	
	Right bank	Left bank	Right bank	Left bank	Set 1	Set 2
<u>Diaptomus reighardi</u>						
4 m to surface						
1	177	194	206	96	316	145
2	175	216	502	74	309	103
x	176	205	354	85	313	124
s	1	76	209	16	5	30
c	0.8	7.6	59.1	18.3	1.6	24.0
8 m to surface						
1	180	146	527	132		
2	122		386	258		
x	151		457	195		
s	41		100	89		
c	27.2		21.8	45.7		
<u>Cyclopoida</u>						
4 m to surface						
1	209	233	49	192	172	174
2	624	216	36	296	186	104
x	417	225	43	244	179	139
s	293.5	12.0	9.2	73.5	9.9	49.5
c	70.4	5.3	21.4	30.1	5.5	35.6
8 m surface						
1	316	49	155	238		
2	93	23	206	328		
x	205	36	181	283		
s	157.7	18.4	36.1	63.6		
c	76.9	51.1	19.9	22.5		

Taxonomic group ^a	Upstream		Near intake		Intake forebay	
	Right bank	Left bank	Right bank	Left bank	Set 1	Set 2
Immature cyclopoids						
4 m to surface						
1	129	194	10	128	86	116
2	250	180	9	74	62	52
$\bar{x}$	190	187	10	101	74	84
s	86	10	1	38	17	45
c	45.0	5.3	0.1	37.8	22.9	53.9
8 m to surface						
1	174	0	103	185		
2	43	164	90	117		
$\bar{x}$	109	82	97	151		
s	93	116	9	48		
c	85.0	141.4	9.5	31.8		
Nauplii						
4 m to surface						
1	2,851	4,969	1,794	3,590	3,506	3,472
2	4,616	3,314	2,625	3,624	5,198	1,959
$\bar{x}$	3,734	4,172	2,210	3,607	4,353	2,716
s	1,248.0	1,170.3	587.6	24.0	1,196.4	1,069.9
c	33.4	28.3	26.6	0.7	27.5	39.4
8 m to surface						
1	3,080	6,104	3,909	3,867		
2	2,131	4,381	3,279	3,444		
$\bar{x}$	2,606	5,243	3,594	3,656		
s	671.0	1,218.3	445.5	299.1		
c	25.7	23.2	12.4	8.2		

^a Numbers (1,2) indicate replicate number; $\bar{x}$ = mean; s = standard deviation; and c = coefficient of variation ($c = s/\bar{x} \times 100$).